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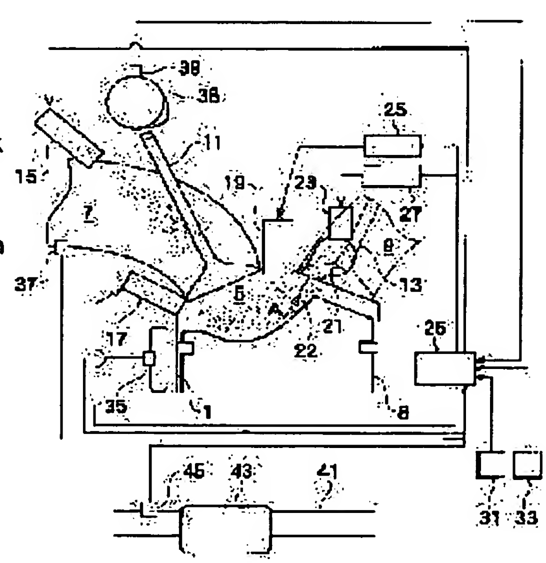
(54) COMPRESSION SELF-IGNITION TYPE GASOLINE INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To avoid hammering in combustion by setting the compression self- ignition combustion to governing combustion assuming the form of multistage heat generation, to be capable of enlarging the compression self-ignition operation range and suppressing the knocking in a spark ignition operation range by reducing the compression ratio an internal EGR rate as much as possible, and stabilize the combustion by determining the starting time of the compression self-ignition.
SOLUTION: A high-temperature combusted gas is left in an auxiliary chamber 21 and fuel-air mixture allowing to flow into the auxiliary chamber 21 via a nozzle hole 22 reacts therewith quicker than that of a combustion chamber 5 so as to form radicals. When an ignition plug 23 for the auxiliary chamber is ignited then, a large quantity of radicals are formed to raise the temperature in the auxiliary chamber 21. The radical jet from the auxiliary chamber 21 to the combustion chamber 5 generates strong shear flow so that the reaction progresses, while the combustion gas mixes with unburnt gas, to induce the combustion reaction quicker than the propagation flame and accelerate the progress of self ignition.



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CLAIMS

[Claim(s)]

[Claim 1] Carry out jump spark ignition of the gaseous mixture of a combustion chamber with the ignition plug prepared in the combustion chamber at the time of jump-spark-ignition operation, and it is burned. In the compressed self-ignition type gasoline internal combustion engine which you carry out [internal combustion engine] self-ignition of the gaseous mixture of a combustion chamber according to a compression operation of a piston at the time of compressed self-ignition operation, and makes it burn The compressed self-ignition type gasoline internal combustion engine characterized by having prepared the accessory cell with the volume smaller than said combustion chamber, having made this accessory cell and said combustion chamber open for free passage by the nozzle hole formed in an opening area smaller than the cross section of an accessory cell, and preparing the ignition plug for accessory cells in said accessory cell.

[Claim 2] The compressed self-ignition type gasoline internal combustion engine according to claim 1 characterized by making the ignition plug for accessory cells light at the time of compressed self-ignition operation.

[Claim 3] The compressed self-ignition type gasoline internal combustion engine according to claim 1 or 2 characterized by making the ignition plug of a combustion chamber light after making the ignition plug for accessory cells light where concentration distribution of a combustion chamber is constituted in homogeneity at the time of heavy load operation.

[Claim 4] The compressed self-ignition type gasoline internal combustion engine according to claim 1 or 2 characterized by making the ignition plug for accessory cells light after making the ignition plug of a combustion chamber light where concentration distribution of a combustion chamber is constituted in an ununiformity at the time of heavy load operation. Internal combustion engine.

[Claim 5] An engine's real compression ratio is a compressed self-ignition type gasoline internal combustion engine according to claim 1 to 4 characterized by being set as the value which does not carry out self-ignition by the auxiliary means to which self-ignition generating is urged, either.

[Claim 6] An engine's real compression ratio is a compressed self-ignition type gasoline internal combustion engine according to claim 5 characterized by being set as the value which does not carry out self-ignition depending on the set point of an auxiliary means, or the combination of two or more auxiliary means.

[Claim 7] The compressed self-ignition type gasoline internal combustion engine according to claim 5 or 6 characterized by having formed the sensor which detects the condition of an auxiliary means and establishing the control means which controls the combustion reaction of degree cycle in response to the input of the detecting signal of this sensor.

[Claim 8] The compressed self-ignition type gasoline internal combustion engine according to claim 1 to 7 characterized by enlarging each point fire stage spacing of the ignition plug for accessory cells, and the ignition plug of a combustion chamber when the extraordinary noise based on knocking or rapid combustion occurs.

[Claim 9] The compressed self-ignition type gasoline internal combustion engine according to claim 8 characterized by having formed the sensor which detects the extraordinary noise based on knocking or rapid combustion, and establishing the control means which controls each point fire stage of the ignition plug for accessory cells, and the ignition plug of a combustion chamber based on the detecting signal of this sensor.

[Claim 10] The compressed self-ignition type gasoline internal combustion engine according to claim 1 to 9 characterized by having prepared the fuel injection valve which injects a fuel in the combustion chamber, and forming it in an oblong configuration corresponding to the configuration of the fuel spray which serves as an oblong configuration along with a piston crestal plane while having arranged the nozzle hole of an

accessory cell in the direction to which the fuel spray from said fuel injection valve points along with a piston crestal plane by the compression stroke.

[Claim 11] The compressed self-ignition type gasoline internal combustion engine according to claim 1 to 9 characterized by having prepared the fuel injection valve which injects a fuel in the combustion chamber, and forming them corresponding to the configuration of the fuel spray which serves as an oblong configuration along with a piston crestal plane while having arranged the nozzle hole of an accessory cell in the direction to which the fuel spray from said fuel injection valve points along with a piston crestal plane by the compression stroke. [two or more]

[Claim 12] The compressed self-ignition type gasoline internal combustion engine according to claim 1 to 11 characterized by carrying out eccentricity of the core of a nozzle hole to the core of an accessory cell.

[Claim 13] The compressed self-ignition type gasoline internal combustion engine according to claim 1 to 12 characterized by preparing the 2nd nozzle hole which opens an accessory cell and a combustion chamber for free passage so that the ignition plug of a combustion chamber may be countered.

[Claim 14] An ignition plug and the ignition plug for accessory cells are a compressed self-ignition type gasoline internal combustion engine according to claim 1 to 13 characterized by having shared the ignition coil and preparing a circuit changing switch in secondary [of this ignition coil].

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Jump spark ignition of the gaseous mixture of a combustion chamber is carried out with the ignition plug prepared in the combustion chamber at the time of jump-spark-ignition operation, this invention burns it, and it is related with the compressed self-ignition type gasoline internal combustion engine which you carry out [internal combustion engine] self-ignition of the gaseous mixture of a combustion chamber according to a compression operation of a piston, and makes it burn at the time of compressed self-ignition operation.
[0002]
[Description of the Prior Art] As an improvement means in the gasoline heat efficiency of internal combustion engine, although Lean-ization of gaseous mixture is mentioned, by combustion by usual jump spark ignition and flame propagation For the time of combustion by the so-called stoichiometry, the catalyst for that combustion becomes unstable and a limitation is naturally generated also in Lean-ization and exhaust air purification at the time of the Lean combustion is the purification engine performance, especially NOx. Since it becomes impossible to demonstrate reducibility ability, Expansion and low NOx of the load range which can operate this Lean combustion The gasoline internal combustion engine of a compressed self-ignition combustion equation which was made to do self-ignition combustion of the gaseous mixture of a combustion chamber according to a compression operation of a piston for the purpose of-izing at the time of an engine's low Naka load etc. is known.
[0003] By the way, the biggest technical problem in a compressed self-ignition type gasoline internal combustion engine is controlling a self-ignition initiation stage the optimal, for example, detects the temperature of a combustion chamber to JP,11-210539,A with the temperature sensor installed in the suction port, and if the amount of EGR gas is controlled or it carries out assist fire of the gas temperature of a combustion chamber with an ignition plug by controlling the valve-opening stage of an inlet valve, he is trying to maintain it to the temperature which produces self-ignition.
[0004]
[Problem(s) to be Solved by the Invention] However, with such a configuration, since distribution arises to the space temperature of a combustion chamber even if it is able to predict the gas temperature near the compression top dead center with the temperature sensor installed in the suction port even if, it cannot ask for the gas temperature of a combustion chamber correctly. That is, since a cylinder wall, a cylinder head wall, or a piston crestal plane is naturally lower than gas temperature, even if it performs assist fire to which self-ignition is urged, the rate of a pressure buildup, advance, i.e., the heat release, of the self-ignition by it or, a reaction rate, etc. cannot be controlled.
[0005] Consequently, there is a possibility that the cylinder internal pressure and temperature near a compression top dead center may increase uniformly, the so-called rapid combustion which compressed self-ignition combustion produces all at once takes place, the rate of a pressure buildup becomes remarkably high, a tap tone is generated, and this serves as noise and has a bad influence also on salability greatly.
[0006] since [moreover,] the temperature of the whole combustion chamber becomes an ununiformity since temperature becomes low by cooling near [the] a peripheral wall side in a combustion chamber, and gaseous mixture does not become homogeneity in the whole combustion chamber, either -- the initiation stage of compressed self-ignition combustion -- ** of the self-ignition conditions of burning space -- therefore it may change irregularly, combustion may become unstable, and the output fluctuation for every cycle may be caused.
[0007] It depends for a chemical reaction like compressed self-ignition combustion on the pressure of a

combustion chamber, temperature, a presentation, concentration of gaseous mixture, etc. Unlike a Diesel engine, the cetane number in the gasoline internal combustion engine using the bad low gasoline of ignitionability as a fuel In order to combine with setting up a compression ratio highly as one technique of forming compressed self-ignition combustion, to maintain the temperature of a combustion chamber highly and to promote activation of gaseous mixture It is necessary to make a hot burnt gas remain in large quantities, and to provide means, such as raising the so-called rate of internal EGR, by setting up the valve overlap of ** and an exhaust air bulb greatly.
[0008] However, when it is set as a high compression ratio and the rate of high internal EGR, the above-mentioned rapid combustion arises, and also the thin limitation and knocking limitation of an air-fuel ratio are produced, the field of compressed self-ignition combustion which can be operated is narrowed, or aggravation of the performance of high rotation and a heavy load region to which jump-spark-ignition combustion is made to perform is brought about.
[0009] Then, it can control knocking generating in a jump-spark-ignition operation region while this invention can avoid tap tone generating at the time of combustion as governing combustion which takes the gestalt of multistage heat release for compressed self-ignition combustion, and can reduce a compression ratio and the rate of internal EGR as much as possible and can expand a compressed self-ignition operating range, and it aims at being able to decide the initiation stage of compressed self-ignition and moreover, stabilizing combustion.
[0010]
[Means for Solving the Problem] In order to attain said purpose, invention of claim 1 Carry out jump spark ignition of the gaseous mixture of a combustion chamber with the ignition plug prepared in the combustion chamber at the time of jump-spark-ignition operation, and it is burned. In the compressed self-ignition type gasoline internal combustion engine which you carry out [internal combustion engine] self-ignition of the gaseous mixture of a combustion chamber according to a compression operation of a piston at the time of compressed self-ignition operation, and makes it burn Prepare an accessory cell with the volume smaller than said combustion chamber, this accessory cell and said combustion chamber are made to open for free passage by the nozzle hole formed in an opening area smaller than the cross section of an accessory cell, and it has considered as the configuration which prepared the ignition plug for accessory cells in said accessory cell.
[0011] Temperature is higher than a combustion chamber, namely, the gaseous mixture which sufficient scavenging is not made, but the inside of an accessory cell serves as space where residual gas remains, and where temperature is high, and flows into an accessory cell through a nozzle hole for this reason since the nozzle hole which connects a combustion chamber and an accessory cell is an opening area smaller than the accessory cell cross section according to the compressed self-ignition type gasoline internal combustion engine of such a configuration generates the radical which is easy to react. For this reason, the average compression ratio and the rate of internal EGR which were being gathered in order to generate compressed self-ignition throughout a combustion chamber until now are lowered, the radical in an accessory cell is generated quickly here, and the trigger space of self-ignition is prepared.
[0012] And if the inside of an accessory cell is lit with the ignition plug for accessory cells, still a lot of radicals will be generated and the temperature in an accessory cell will rise. As for ignition timing, it is desirable to consider as a heat release period with sufficient thermal efficiency, and the radical in an accessory cell generated by doing in this way is spouted to a combustion chamber side through a nozzle hole. A reaction advances, induction of the combustion reaction earlier than flame propagation is carried out by the combustion chamber, strong shear flow arising and a burnt gas and a unburnt gas being mixed by the radical jet to the combustion chamber from an accessory cell, and advance of self-ignition is promoted.
[0013] The self-ignition combustion which made the trigger the radical spouted from such a nozzle hole to a combustion chamber turns into governing combustion which takes the gestalt of multistage heat release unlike the self-ignition combustion generated in simultaneous rising throughout a combustion chamber, and, thereby, tap tone generating at the time of combustion is avoided.
[0014] Invention of claim 2 is considered as the configuration made to light the ignition plug for accessory cells at the time of compressed self-ignition operation in the configuration of invention of claim 1.
[0015] According to the above-mentioned configuration, initiation of the reaction which serves as a trigger of self-ignition by making the ignition plug for accessory cells light at the time of compressed self-ignition operation is discovered within an accessory cell.
[0016] In the configuration of claim 1 or invention of two, invention of claim 3 is in the condition which constituted concentration distribution of a combustion chamber in homogeneity at the time of heavy load

operation, and after making the ignition plug for accessory cells light, it is considered as the configuration made to light the ignition plug of a combustion chamber.
[0017] The location of an accessory cell has the realistic configuration which becomes an exhaust air system, also when a wall temperature and direct injection are assumed. Although the ignition plug in a combustion chamber becomes near the combustion chamber core near a cylinder shaft, the propagation flame by this ignition plug is understood that the propagation to exhaust side space is generally earlier than inspired air flow path space. This is because a propagation flame is hard to be quenched on an exhaust side wall surface with high temperature. Consequently, it is easy to generate the self-ignition used as the trigger of knocking by the propagation flame at the time of heavy load operation in an inspired air flow path. therefore, the ignition to the ignition plug for accessory cells -- first -- carrying out -- a high-speed jet -- a combustion chamber -- blowing off -- an inspired air flow path -- gaseous mixture is burned, and the whole combustion chamber is burned with the propagation flame by the combustion chamber side ignition plug which exists at the core a degree, controlling knocking.
[0018] In the configuration of claim 1 or invention of two, invention of claim 4 is in the condition which constituted concentration distribution of a combustion chamber in the ununiformity at the time of heavy load operation, and after making the ignition plug of a combustion chamber light, it is considered as the configuration made to light the ignition plug for accessory cells.
[0019] for example, a combustion chamber -- a direct injection configuration -- carrying out -- fuel injection timing -- a compression stroke, then heavy load operation -- also setting -- stratification combustion -- possible -- thereby -- gaseous mixture -- the ununiformity space of concentration can be formed. When concentration distribution of a combustion chamber is an ununiformity, even if the whole air-fuel ratio is equivalent ratio 1, space deeper than this and thin space exist in a combustion chamber. rich by blowing off the jet by the ignition from an accessory cell to such ununiformity space -- it becomes possible to carry out the turbulence of the soot which is easy to be formed under gaseous mixture, and to oxidize it.
[0020] Invention of claim 5 is set as the value which does not carry out self-ignition by the auxiliary means urged to self-ignition generating, either for an engine's real compression ratio in the configuration of invention of claim 1 thru/or either of 4.
[0021] According to the above-mentioned configuration, since an engine's real compression ratio does not need to carry out induction of the self-ignition reaction by compression, it can be set as the low compression ratio which a reaction does not start by the auxiliary means to which what kind of self-ignitions other than ignition are urged, either.
[0022] It is set as the value to which an engine's real compression ratio does not carry out self-ignition of the invention of claim 6 in the configuration of invention of claim 5 depending on the set point of an auxiliary means, or the combination of two or more auxiliary means.
[0023] According to the above-mentioned configuration, the self-ignition of the combustion chamber by ignition to the ignition plug for accessory cells within an accessory cell becomes easy.
[0024] Invention of claim 7 is considered as the configuration which formed the sensor which detects the condition of an auxiliary means and established the control means which controls the combustion reaction of degree cycle in response to the input of the detecting signal of this sensor in the configuration of claim 5 or invention of six.
[0025] According to the above-mentioned configuration, the condition for every cycle of an auxiliary means is detected, the ignition timing of degree cycle is changed suitably, and a reaction is controlled by the sensor.
[0026] In the configuration of invention of claim 1 thru/or either of 7, invention of claim 8 is considered as the configuration which enlarges each point fire stage spacing of the ignition plug for accessory cells, and the ignition plug of a combustion chamber, when the extraordinary noise based on knocking or rapid combustion occurs.
[0027] The manifestation of the propagation flame which made ignition to an ignition plug the trigger can be performed uniquely in time. On the other hand, if the subsequent reaction speed of advance is too quick, in the burn-out region of a lifting and a propagation flame, a reaction will advance a rapid pressure buildup at a stretch, it will end, and knocking will be caused. Then, in such a case, the extraordinary noise based on knocking or rapid combustion is avoided by enlarging ignition timing spacing of two ignition plugs.
[0028] Invention of claim 9 is considered as the configuration which formed the sensor which detects the extraordinary noise based on knocking or rapid combustion, and established the control means which controls each point fire stage of the ignition plug for accessory cells, and the ignition plug of a combustion chamber based on the detecting signal of this sensor in the configuration of invention of claim 8.

[0029] According to the above-mentioned configuration, knocking and an extraordinary noise are stopped by detecting this and making suitable each point fire stage of the ignition plug for accessory cells of degree cycle, and a combustion chamber inner point fire plug with the sway sensor formed in the pressure sensor formed in the combustion chamber, or the cylinder block, at the time of knocking or extraordinary-noise generating.
[0030] In the configuration of invention of claim 1 thru/or either of 9, invention of claim 10 prepares the fuel injection valve which injects a fuel to a combustion chamber, and it has formed it in the oblong configuration corresponding to the configuration of the fuel spray which serves as an oblong configuration along with a piston crestal plane while arranging in the direction in which the fuel spray from said fuel injection valve points to the nozzle hole of an accessory cell along with a piston crestal plane by the compression stroke.
[0031] according to the above-mentioned configuration, the fuel injected from the fuel injection valve should flow along with a piston crestal plane by the compression stroke, and pass a nozzle hole -- the gas containing a lot of radicals in the accessory cell which enters efficiently in an accessory cell and is generated after that by ignition to the ignition plug for accessory cells -- a nozzle hole -- flowing backwards -- the gaseous mixture of a combustion chamber -- it flows in over the inner large range.
[0032] In the configuration of invention of claim 1 thru/or either of 9, invention of claim 11 prepares the fuel injection valve which injects a fuel to a combustion chamber, and it forms them corresponding to the configuration of the fuel spray which serves as an oblong configuration along with a piston crestal plane while arranging in the direction in which the fuel spray from said fuel injection valve points to the nozzle hole of an accessory cell along with a piston crestal plane by the compression stroke. [two or more]
[0033] according to the above-mentioned configuration, the fuel injected from the fuel injection valve should flow along with a piston crestal plane by the compression stroke, and pass two or more nozzle holes -- the gas containing a lot of radicals in the accessory cell which enters efficiently in an accessory cell and is generated after that by ignition to the ignition plug for accessory cells -- two or more nozzle holes -- flowing backwards -- the gaseous mixture of a combustion chamber -- it flows in over the inner large range.
[0034] Invention of claim 12 is considered as the configuration to which eccentricity of the core of a nozzle hole was carried out to the core of an accessory cell in the configuration of invention of claim 1 thru/or either of 11.
[0035] According to the above-mentioned configuration, if the gaseous mixture of a combustion chamber flows in an accessory cell through a nozzle hole by compression of a piston, within an accessory cell, a vortex will occur and gaseous mixture will reach to the deepest part of an accessory cell.
[0036] Invention of claim 13 is considered as the configuration which prepared the 2nd nozzle hole which opens an accessory cell and a combustion chamber for free passage so that the ignition plug of a combustion chamber might be countered in the configuration of invention of claim 1 thru/or either of 12.
[0037] According to the above-mentioned configuration, the radical generated by ignition spouts towards the ignition plug of a combustion chamber within an accessory cell. Moreover, before the ignition plug for accessory cells is lit, the radical of a combustion chamber when a combustion chamber inner point fire plug lights becomes easy to flow into an accessory cell by preparing the 2nd nozzle hole.
[0038] In the configuration of invention of claim 1 thru/or either of 13, an ignition plug and the ignition plug for accessory cells share an ignition coil, and invention of claim 14 is considered as the configuration which prepared the circuit changing switch in secondary [of this ignition coil].
[0039] According to the above-mentioned configuration, it will be in the condition that either of the ignition plug of a combustion chamber and the ignition plug for accessory cells is lit, by changing a circuit changing switch.
[0040]
[Effect of the Invention] According to invention of claim 1, it sets to a compressed self-ignition type gasoline internal combustion engine. Make the accessory cell and combustion chamber where the volume is smaller than a combustion chamber open for free passage by the nozzle hole formed in an opening area smaller than the cross section of an accessory cell, and it writes as the configuration which prepared the ignition plug for accessory cells in said accessory cell. The gaseous mixture which sufficient scavenging is not made, but the inside of an accessory cell serves as space where residual gas remains, and where temperature is high, and flows into an accessory cell through a nozzle hole for this reason The radical with temperature higher than a combustion chamber which is easy to react can be generated, and the average compression ratio and the rate of internal EGR which were being gathered in order to generate compressed self-ignition throughout a combustion chamber until now can be lowered. Moreover, the inside of the

accessory cell into which gaseous mixture flowed serves as trigger space of self-ignition, by lighting the ignition plug for accessory cells here, still a lot of radicals are generated and carry out a temperature rise, and the radical in this accessory cell can promote advance of self-ignition, blowing off to a combustion chamber side through a nozzle hole, and a burnt gas and a unburnt gas being mixed. Furthermore, the self-ignition combustion which made the trigger the radical spouted from such a nozzle hole turns into governing combustion which takes the gestalt of multistage heat release unlike the self-ignition combustion generated in simultaneous rising throughout a combustion chamber, and, thereby, can avoid tap tone generating at the time of combustion.
[0041] When it will be in compressed self-ignition operational status, initiation of the reaction used as the trigger of compressed self-ignition can be made according to invention of claim 2, to discover within an accessory cell, since it was made to make the ignition plug for accessory cells light at the time of compressed self-ignition operation.
[0042] Since it was made to make the ignition plug of a combustion chamber according to invention of claim 3 light where concentration distribution of a combustion chamber is constituted in homogeneity at the time of heavy load operation after making the ignition plug for accessory cells light, a high-speed jet blows off from an accessory cell to a combustion chamber by ignition to the ignition plug for accessory cells, and the whole combustion chamber can be burned next with the propagation flame based on ignition to a combustion chamber side ignition plug, controlling knocking.
[0043] Since it was made to make the ignition plug for accessory cells light after making the ignition plug of a combustion chamber light, the soot which is easy to be formed under the fault rich mixture of a combustion chamber can be made to be able to disturb, and it can be made according to invention of claim 4, to oxidize by the jet which blows off from an accessory cell to a combustion chamber, where concentration distribution of a combustion chamber is constituted in an ununiformity at the time of heavy load operation.
[0044] According to invention of claim 5, since it is set as the value which does not carry out self-ignition by the auxiliary means to which self-ignition generating is urged, either, an engine's real compression ratio can be set as the low compression ratio which a reaction does not start by the auxiliary means to which what kind of self-ignitions other than ignition are urged, either.
[0045] According to invention of claim 6, an engine's real compression ratio can make self-ignition combustion of the combustion chamber which made the trigger the manifestation of the reaction by ignition to the ignition plug for accessory cells perform easily, when it can be set as a low compression ratio, since it is set as the value which does not carry out self-ignition depending on the set point of an auxiliary means, or the combination of two or more auxiliary means.
[0046] Since according to invention of claim 7 the sensor which detects the condition of an auxiliary means was formed and the control means which controls the combustion reaction of degree cycle in response to the input of the detecting signal of this sensor was established, the combustion fluctuation for every cycle can be prevented and the stable self-ignition combustion can be made to perform.
[0047] When the extraordinary noise based on knocking or rapid combustion occurs, in order to enlarge each point fire stage spacing of the ignition plug for accessory cells, and the ignition plug of a combustion chamber according to invention of claim 8, the rate of combustion is controlled and the extraordinary noise based on knocking or rapid combustion can be controlled.
[0048] Since the control means which controls each point fire stage of the ignition plug for accessory cells and the ignition plug of a combustion chamber was established based on the detecting signal of a sensor which detects the extraordinary noise based on knocking or rapid combustion according to invention of claim 9, knocking and an extraordinary noise can be stopped by detecting knocking and an extraordinary noise by the sensor and making suitable ignition timing spacing of the ignition plug for accessory cells of degree cycle, and a combustion chamber inner point fire plug, and an ignition existence judgment.
[0049] While arranging in the direction in which the fuel injection valve which injects a fuel is prepared in a combustion chamber, and the fuel spray from said fuel injection valve points to the nozzle hole of an accessory cell along with a piston crestal plane by the compression stroke according to invention of claim 10 Since it formed in the oblong configuration corresponding to the configuration of the fuel spray which serves as an oblong configuration along with a piston crestal plane, The fuel spray injected from the fuel injection valve meets and flows a piston crestal plane by the compression stroke, and it enters efficiently in an accessory cell from a nozzle hole. The gas containing a lot of radicals in the accessory cell generated after that by ignition to the ignition plug for accessory cells flows in over the large range of the gaseous mixture of a combustion chamber from the nozzle hole of an oblong configuration, and can contribute to

promotion of a reaction.
[0050] While arranging in the direction in which the fuel injection valve which injects a fuel is prepared in a combustion chamber, and the fuel spray from said fuel injection valve points to the nozzle hole of an accessory cell along with a piston crestal plane by the compression stroke according to invention of claim 11 Since more than one were formed corresponding to the configuration of the fuel spray which serves as an oblong configuration along with a piston crestal plane, The fuel spray injected from the fuel injection valve meets and flows a piston crestal plane by the compression stroke, and it enters efficiently in an accessory cell from two or more nozzle holes. The gas containing a lot of radicals in the accessory cell generated after that by ignition to the ignition plug for accessory cells flows in over the large range of the gaseous mixture of a combustion chamber from two or more nozzle holes, and can contribute to promotion of a reaction.
[0051] the gaseous mixture which flows in an accessory cell through a nozzle hole from a combustion chamber by compression of a piston since eccentricity of the core of a nozzle hole was carried out to the core of an accessory cell according to invention of claim 12 -- the inside of an accessory cell -- a vortex -- becoming -- up to the deepest part of an accessory cell -- reaching -- the ignition to an accessory cell internal use ignition plug -- certain ******** -- things are made.
[0052] Since according to invention of claim 13 the 2nd nozzle hole which opens an accessory cell and a combustion chamber for free passage was prepared so that the ignition plug of a combustion chamber might be countered, the radical generated by ignition can blow off towards the ignition plug of a combustion chamber within an accessory cell, and ignition by the ignition plug can be made to ensure. Moreover, the radical of the combustion chamber by ignition to a combustion chamber inner point fire plug becomes easy to flow into an accessory cell by preparing the 2nd nozzle hole.
[0053] According to invention of claim 14, since the ignition coil was shared and the circuit changing switch was prepared in secondary [of this ignition coil], it becomes unnecessary for an ignition plug and the ignition plug for accessory cells to form two ignition systems corresponding to two ignition plugs, and they can contribute them to reduction of components mark.
[0054]
[Embodiment of the Invention] Hereafter, the gestalt of implementation of this invention is explained based on a drawing.
[0055] Drawing 1 is the whole compressed self-ignition type gasoline internal combustion engine block diagram showing one gestalt of implementation of this invention, a piston 3 is held possible [vertical movement] in a cylinder 1, and the intake valve 11 and the ****** bulb 13 are formed in the suction port 7 and the exhaust air port 9 which are open for free passage to a combustion chamber 5, respectively. An intake valve 11 and two ****** bulbs 13 are formed in the direction which intersects perpendicularly with space in drawing 1 R> 1, respectively, and, thereby, the combustion chamber 5 constitutes the PENTO roof mold.
[0056] The fuel-supply system is writing together the case of suction-port injection, and the case of direct injection, and any may be used for it by this example. That is, as a configuration which forms the low voltage fuel injection valve 15 in suction-port injection, a fuel is injected to a suction port 7 by this fuel injection valve 15, and injection supply of the direct fuel is carried out by this fuel injection valve 17 in a combustion chamber 5 as a configuration which forms the high-pressure fuel injection valve 17 in the case of direct injection.
[0057] In addition, in stratification combustion, it is premised on the direct injection configuration when fuel injection timing is in a compression stroke by future explanation (Late injection). Moreover, in the case of homogeneity premixed combustion, it is premised on the suction-port injection configuration. However, if an inhalation-of-air line is injection even if it is a direct injection configuration, it will become homogeneity premixed combustion.
[0058] An ignition plug 19 is installed in the center of the combustion chamber 5 of a PENTO roof mold, and the accessory cell 21 with the volume smaller than a combustion chamber 5 is formed between [two] exhaust air port 9 near this ignition plug 19. This is also for being for injecting the fuel spray towards the exhaust air bulb 13 side, and securing the inside of an accessory cell 21 to the high condition of a wall temperature by the fuel injection valve 17 installed in the intake valve 11 side, when a direct injection configuration is assumed. The accessory cell 21 and the combustion chamber 5 are open for free passage with the nozzle hole 22 formed in an opening area smaller than the cross section of an accessory cell 21.
[0059] And the ignition plug 23 for accessory cells is formed near the deepest part of an accessory cell 21. Since this ignition plug 23 for accessory cells does not use it fundamentally in the high service condition of a load, it may be smaller than the usual ignition plug 19, and does not need to take into consideration the

quality of the material or structure where electrode degradation was minded, the cure against dielectric breakdown or spark gap die length, extent of surrounding cooling, etc., about 19 usual ignition plug.

[0060] The ignition systems 25 and 27 equipped with the ignition coil etc. are connected to the ignition plug 19 and the ignition plug 23 for accessory cells in a combustion chamber 5, respectively, and ignition control of these each point fire systems 25 and 27 is carried out to them with the electronic control unit 29 as a control means. Each detection value of the engine rotational frequency sensor 31, the load sensor 33, and a coolant temperature sensor 35 is further inputted into this electronic control unit 29.

[0061] Moreover, the table showing the relation between the water temperature which shows an engine rotational frequency, an engine load, and standby, and the ignition gestalt of an ignition plug 19 and the ignition plug 23 for accessory cells is stored in the electric control unit 29. And an electronic control unit 29 grasps a service condition in response to the input of the detection value of said various sensors, and judges both [any of an ignition plug 19 and the ignition plug 23 for accessory cells, or] are lit.

[0062] Drawing 2 is a flow chart which shows ignition control actuation of each point fire plugs 19 and 23 by the above-mentioned electronic control unit 29. an engine's operational status -- a heavy load -- (step 201) and standby -- (step 203) -- in the case of compressed self-ignition operational status, (step 205) and the ignition plug 23 for accessory cells are lit further (step 207).

[0063] As shown in drawing 3 from Curve a, let compressed self-ignition operation be a field by the side of low rotation and a low load (A). In addition, in drawing 3 , a stratification jump-spark-ignition field and the field (C) of the field (B) surrounded with Curve a and Curve b where field (B)' by which it was surrounded with Curve b and the broken line c was surrounded with the homogeneity lean burn jump-spark-ignition field, Curve b, and Curve d are homogeneity SUTOIKI (chemically correct mixture ratio) jump-spark-ignition fields.

[0064] The tooth lead angle of the ignition timing of the ignition plug 23 for accessory cells is carried out as shown in drawing 4 , so that an engine rotational frequency becomes high, and, so that an engine load becomes low. If an engine rotational frequency becomes high, by whenever [crank angle], real reaction time must be short also in the same reaction period. For this reason, in order to obtain an efficient heat release stage (it corresponds to MBT in ignition combustion), it is necessary to bring ignition timing forward, so that it becomes high rotation. Moreover, since it is necessary to supply more fuels when an engine load becomes high, the rate of a pressure buildup accompanying a reaction becomes more rapid, and is connected with the erosion of the part which constitutes the combustion chamber 5 by the rapid heat release which gives a sound with the same displeasure as a knock, and an engine a damage. Ignition timing will be delayed, when it is required for avoiding this to delay a heat release stage, therefore an engine load becomes high.

[0065] Temperature is higher than a combustion chamber 5, namely, the gaseous mixture which sufficient scavenging is not made in an accessory cell 21 like an exhaust air line since it is an opening area smaller than the cross section of an accessory cell 21, but the nozzle hole 22 which connects a combustion chamber 5 and an accessory cell 21 serves as space where residual gas remains, and where temperature is high, and flows into an accessory cell 21 through a nozzle hole 22 according to a compression stroke in this condition generates the radical which is easy to react. For this reason, the average compression ratio and the rate of internal EGR which were being gathered in order to generate compressed self-ignition throughout the inside of a combustion chamber 5 until now are lowered, the radical in an accessory cell 21 is generated quickly here, and the trigger space of self-ignition is prepared.

[0066] It is possible for an engine's above-mentioned real compression ratio to be set as the value which does not carry out self-ignition even if it uses the auxiliary means to which self-ignition generating is urged, for example, an intake-air-temperature heating means, the increment means in the amount of residual gas, an air-fuel ratio, etc., and to generate self-ignition by this by making jump spark ignition of the ignition plug 23 for accessory cells into a trigger. Moreover, as an engine's real compression ratio, you may set it as the value which does not carry out self-ignition depending on the set point of the above-mentioned auxiliary means, or the combination of two or more auxiliary means. This is easy to generate the self-ignition by jump spark ignition of the ignition plug 23 for accessory cells.

[0067] If the ignition plug 23 for accessory cells is lit, still a lot of radicals will be generated and the temperature in an accessory cell 21 will rise. Thus, the radical in the accessory cell 21 generated is spouted to a combustion chamber 5 side through a nozzle hole 22. A reaction advances, induction of the combustion reaction earlier than flame propagation is carried out by the combustion chamber, strong shear flow arising and a burnt gas and a unburnt gas being mixed by the jet of the radical to the combustion chamber 5 from an accessory cell 21, and advance of self-ignition is promoted.

[0068] The self-ignition combustion which made the trigger the radical spouted from such a nozzle hole 22 turns into governing combustion which takes the gestalt of multistage heat release unlike the self-ignition combustion generated in simultaneous rising the whole region in a combustion chamber 5, and, thereby, tap tone generating at the time of combustion is avoided.
[0069] Drawing 5 is the indicator diagram showing the reaction rate by ignition to the ignition plug 23 for accessory cells. According to this, the heat release by ignition within an accessory cell 21 happens to the beginning, this heat release and pressure buildup are extent which added the pressure increment to the motoring wave, but thereby, the pressure in a combustion chamber 5 rises. Even if the air-fuel ratio in a combustion chamber 5 is in the rarefaction side besides an inflammable air-fuel ratio, it becomes easy to react by this, and finally it reacts by radical supply from an accessory cell 21. It is obtained by ignition as a result, the heat release period, i.e., the output, with little fluctuation for every cycle.
[0070] When judged as non-warming up at said step 203, and when it is judged at step 205 that it is not compressed self-ignition operation, do not light the ignition plug 23 for accessory cells, but the ignition plug 19 in a combustion chamber 5 is made to light (step 209), and combustion by the usual propagation flame is made to perform.
[0071] Moreover, form the cam actuation angle sensor 39 in the good fluctuation valve system 38 as for which enables it to detect the inhalation-of-air heating condition by inhalation-of-air heating means to by_which form an intake temperature sensor 37 and it is not illustrated to a suction port 7 with the configuration of drawing 1 , and bulb overlap is made to adjustable, it enables it to detect the amount change of residual gas, the air-fuel ratio sensor (O2 sensor) 45 installs in the upstream of the catalyst 43 further prepared in the exhaust pipe 41, and it enables it to have detected the air-fuel ratio. By this, the combustion condition for every cycle can be grasped, the reaction of degree cycle can be controlled by extent of the reaction, and it becomes possible to make self-ignition combustion perform without fluctuation for every cycle.
[0072] Although it judges whether it is combustion by homogeneity premixing when an engine is judged to be a heavy load at step 201 in said drawing 2 , the direct injection configuration is taken into consideration here, therefore it judges whether it is Late injection (step 211). When judged as Late injection, the ignition plug 19 in a combustion chamber 5 is lit first (step 213), and the ignition plug 23 for accessory cells is lit continuously (step 215). In heavy load operational status, the fuel near an ignition plug 19 and the ignition plug 23 for accessory cells is deep by Late injection. Therefore, even if it is in the conditions that an air-fuel ratio is thinner than an inflammable air-fuel ratio like 40, it is in an inflammable air-fuel ratio about 19 or about 23 each point fire plug space.
[0073] In this case, if an injection fuel is burned altogether at a suitable period, coexistence of an output and exhaust air can be aimed at. however, rich -- a mixing ratio -- combustion with insufficient oxygen may exist in the bottom. This causes exhaust air aggravation of HC, soot, CO, etc. In order to avoid this, it is necessary to make mixing with a rich air-fuel ratio and the oxygen in the other space perform with sufficient timing. For this reason, the ignition in an accessory cell 21 is made to perform later than the ignition in a combustion chamber 5, with the emerged flame from the accessory cell 21 after ignition within an accessory cell 21, the inside of a combustion chamber 5 is made to disturb, mixing is promoted, the exhaust air engine performance especially NOx, and soot generating are controlled by this, and coexistence with the output of a heavy load operation demand can be aimed at.
[0074] The heat release period should be performed at the effective stage and effective period when an output is obtained, and even if it follows on the rise of a rotational frequency, it should not change the ignition timing difference of both ignition plugs a lot by whenever [crank angle]. Drawing 6 shows the ignition timing of two ignition plugs to an engine rotational frequency, is a continuous line about the ignition timing of the ignition plug 19 in a combustion chamber 5, and shows the ignition timing of the ignition plug 23 for accessory cells with a broken line, respectively.
[0075] When it is judged at said step 211 that it is not Late injection, it lights from the ignition plug 23 for accessory cells (step 217), and the inhalation-of-air system side space in the combustion chamber 5 to which a nozzle hole 22 points is first burned with the emerged flame from an accessory cell 21. Next, combustion of the remaining space in a combustion chamber 5 is performed by the propagation flame by the ignition to the ignition plug 19 in a combustion chamber 5 (step 609). since a combustion period becomes short since the combustion space in the combustion chamber 5 by ignition to an ignition plug 19 narrows, and the inspired air flow path space of a combustion chamber 5 finishes combustion previously -- knocking generating -- control -- or suppose that it is slight.
[0076] Drawing 7 shows the ignition timing to the engine rotational frequency in the case of making the

ignition plug 19 in a combustion chamber 5 light after ignition to the ignition plug 23 for accessory cells, is a continuous line about the ignition timing of the ignition plug 19 in a combustion chamber 5, and shows the ignition timing of the ignition plug 23 for accessory cells with the broken line, respectively.
[0077] Drawing 8 shows the gestalt of other operations of this invention. The gestalt of this operation has added the sway sensor 47 which detects vibration of an engine, and shows the control action in this case to drawing 9 . In this case, in step 201 of said drawing 2 , when an engine's operational status is judged to be ********, it is judged whether in response to the input of the detection value of a sway sensor 47, the extraordinary noise based on knocking ****** rapid combustion occurred (step 901). Here, when knocking or an extraordinary noise occurs, where difference |Igm-Igs| of the ignition timing Igm of the ignition plug 19 in a combustion chamber 5 and the ignition timing Igs of the ignition plug 23 for accessory cells is enlarged, the ignition plug 23 (ignition plug 19) for accessory cells is lit following the ignition (step 905) to the ignition plug 19 (ignition plug 23 for accessory cells) in (step 903) and a combustion chamber 5 (step 907).
[0078] On the contrary, when knocking or an extraordinary noise has not occurred, where difference |Igm-Igs| of the ignition timing Igm of the ignition plug 19 in a combustion chamber 5 and the ignition timing Igs of the ignition plug 23 for accessory cells is made small, the ignition plug 23 (ignition plug 19) for accessory cells is lit following the ignition (step 905) to the ignition plug 19 (ignition plug 23 for accessory cells) in (step 909) and a combustion chamber 5 (step 907).
[0079] The manifestation of the propagation flame which made ignition to an ignition plug the trigger can be performed uniquely in time. On the other hand, if the subsequent reaction speed of advance is too quick, in the burn-out region of a lifting and a propagation flame, a reaction will advance a rapid pressure buildup at a stretch, it will end, and knocking will be caused. Then, in such a case, the extraordinary noise based on knocking or rapid combustion is avoidable by enlarging ignition timing spacing of two ignition plugs 19 and 23.
[0080] Moreover, an ignition plug 19 and the ignition plug 23 for accessory cells set the ignition system equipped with the ignition coil to one of the ignition systems 25, and form a circuit changing switch 49 in secondary [of this ignition system 25], and he is trying to change two ignition plugs 19 and 23 with a circuit changing switch 49 in above-mentioned drawing 8 . Thereby, it becomes unnecessary to form two ignition systems corresponding to two ignition plugs 19 and 23, and can contribute to reduction of components mark.
[0081] Drawing 10 is A view Fig. of drawing 1 , and shows the configuration of a nozzle hole 22. This nozzle hole 22 is made into the ellipse long in the direction which intersects perpendicularly with space in drawing 1 , i.e., the direction which meets the ridge line of a PENTO roof. As this has shown at drawing 1 in Late injection, the fuel spray from the high-pressure fuel injection valve 17 has the composition of going up to the space which the ignition plug 19 and nozzle hole 22 in a combustion chamber 5 overlook, meeting a piston crestal plane. Since it becomes an oblong configuration when a piston crestal plane is met, even if an injection configuration is injection valve axial symmetry, the nozzle hole 22 of the above-mentioned ellipse incorporates spraying of this oblong configuration in an accessory cell 21 efficiently. Moreover, the gas containing a lot of radicals in the accessory cell 21 generated by ignition to the ignition plug 23 for accessory cells flows in over the large range of the gaseous mixture in a combustion chamber 5 from the nozzle hole 22 of an oblong configuration, and becomes effective in promotion of a reaction.
[0082] Drawing 11 replaces a nozzle hole 22 with the ellipse of drawing 10 , and shows the example which prepared two or more nozzle-hole 22a of a small-circle form along the direction of a major axis of an ellipse.

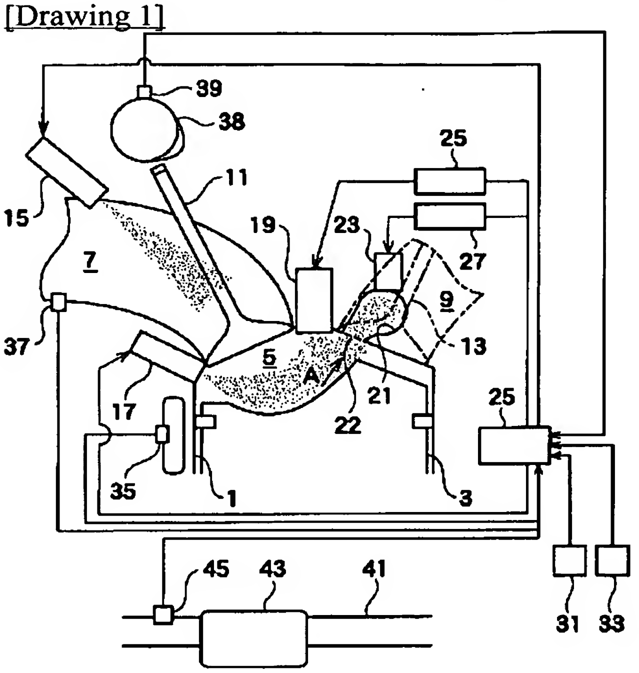
[0083] Drawing 12 shows the example to which eccentricity of the core of a nozzle hole 22 was carried out to the core of an accessory cell 21. An ellipse is also available for it, even when the nozzle hole 22 in this case is circular. In this example, if the gaseous mixture in a combustion chamber 5 flows in an accessory cell 21 through a nozzle hole 22 by compression of a piston 3, within an accessory cell 21, a vortex will occur and gaseous mixture will reach to the deepest part of an accessory cell 21. Thereby, ignition to the accessory cell internal use ignition plug 23 can be made to ensure.
[0084] Drawing 13 is the example which in addition to the configuration of drawing 12 formed the 2nd nozzle hole 51 which opens an accessory cell 21 and a combustion chamber 5 for free passage so that the spark gap of the ignition plug 19 in a combustion chamber 5 might be countered. The radical generated by ignition can blow off towards the spark gap of the ignition plug 19 in a combustion chamber 5 by this within an accessory cell 21, and ignition by the ignition plug 19 can be made to ensure. Moreover, before the ignition plug 23 for accessory cells is lit, the radical in the combustion chamber 5 when the ignition plug 19

in a combustion chamber 5 is lit becomes easy to flow into an accessory cell 21 by forming the 2nd nozzle hole 51.

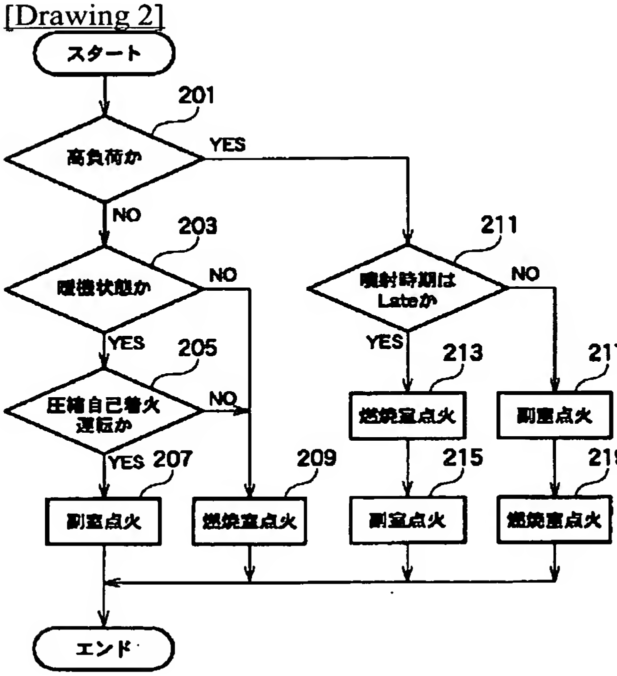
[Translation done.]

DRAWINGS

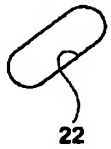
[Drawing 1]



[Drawing 2]

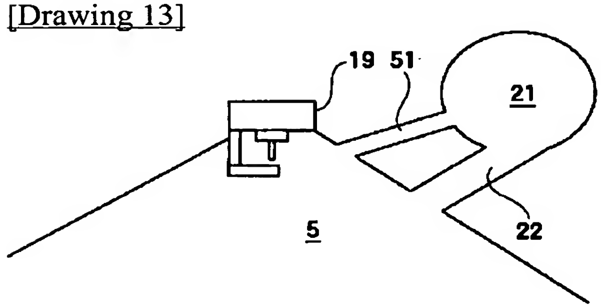


[Drawing 10]

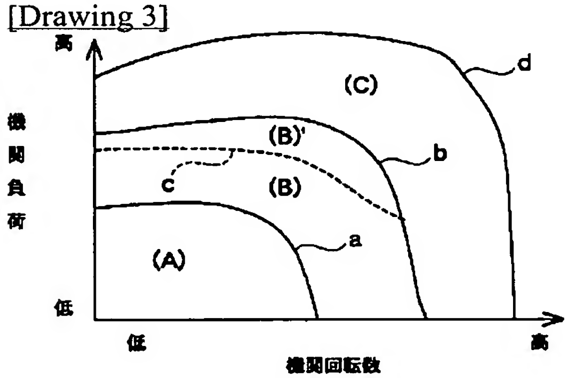


[Drawing 11]

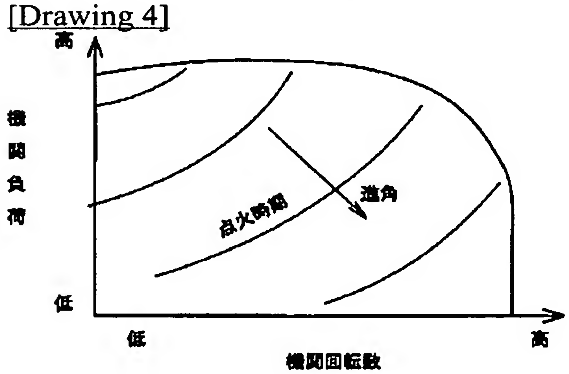
[Drawing 13]



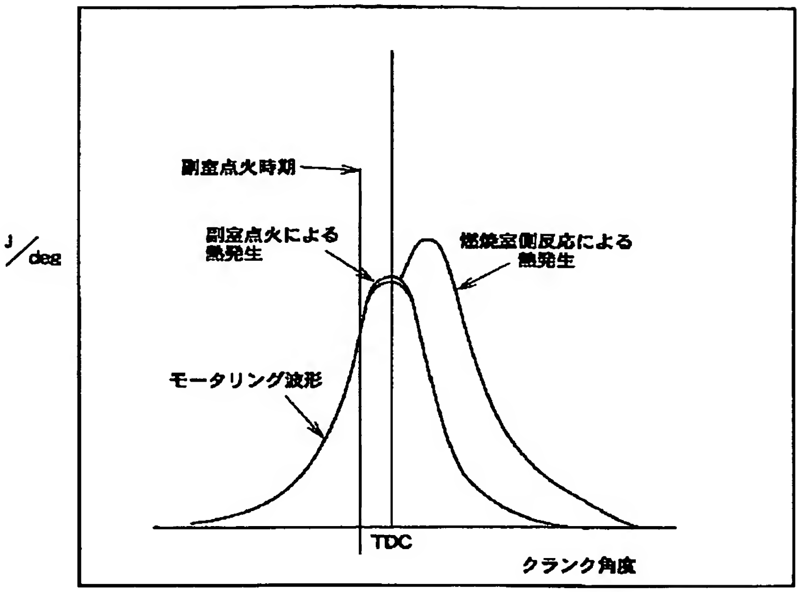
[Drawing 3]



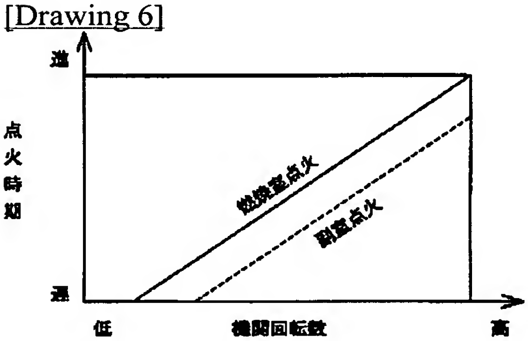
[Drawing 4]



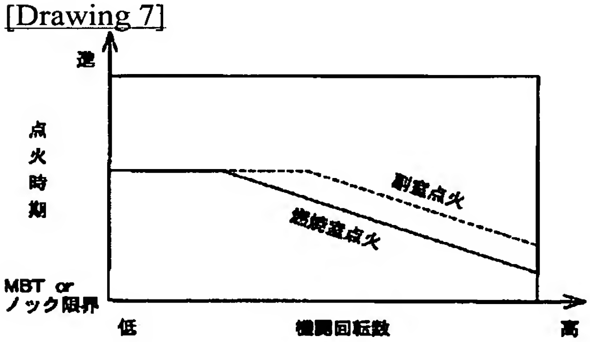
[Drawing 5]



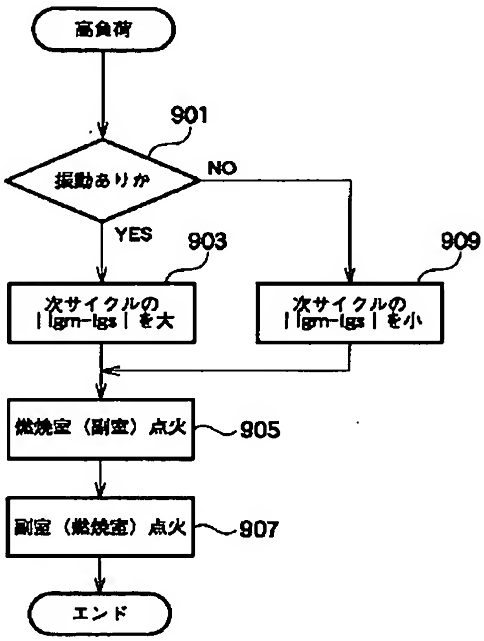
[Drawing 6]



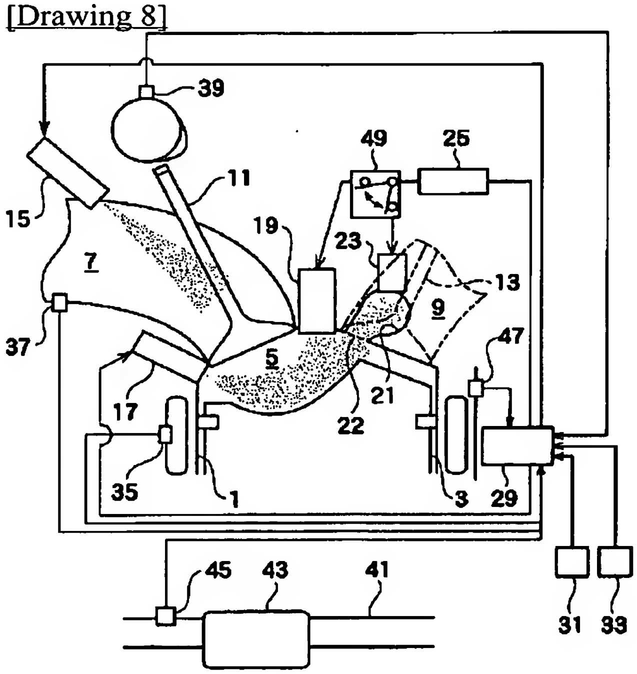
[Drawing 7]



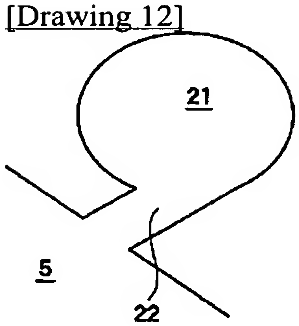
[Drawing 9]



[Drawing 8]



[Drawing 12]



[Translation done.]

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			Ｍ　３Ｇ０６６
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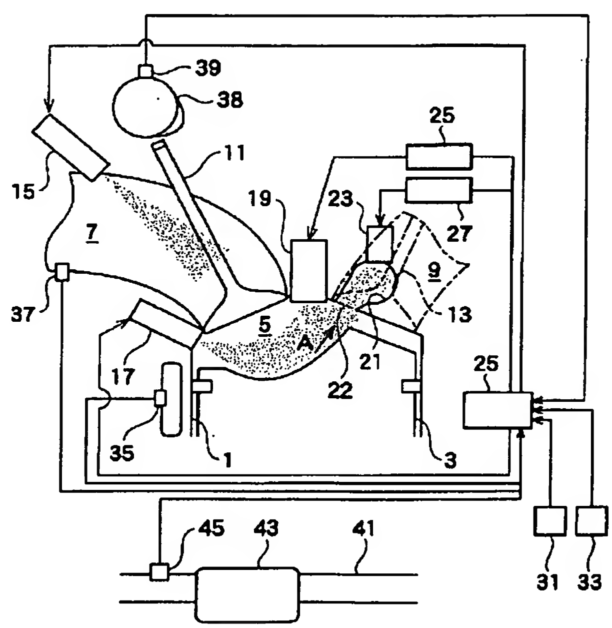
(54)【発明の名称】　圧縮自己着火式ガソリン内燃機関

(57)【要約】
【課題】　圧縮自己着火燃焼を多段的な熱発生の形態をとる調速燃焼として燃焼時の打音発生を回避しかつ、圧縮比および内部ＥＧＲ率を可及的に低減できて圧縮自己着火運転領域を拡大できるとともに火花点火運転域でのノッキング発生を抑制でき、しかも、圧縮自己着火の開始時期を確定できて燃焼を安定化させる。
【解決手段】　副室２１内に高温の既燃ガスが残留し、噴口２２を通して副室２１に流入する混合気が燃焼室５よりも早く反応してラジカルを形成し、ここで副室用点火プラグ２３を点火すると、さらに多量のラジカルが生成され、副室２１内の温度が上昇する。副２１室から燃焼室５へのラジカルの噴流により、強い剪断流れが生じ、既燃ガスと未燃ガスが混じりつつ反応が進行して伝播火炎よりも速い燃焼反応が燃焼室５内で誘起され、自己着火の進行が促進される。



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【特許請求の範囲】

【請求項１】　火花点火運転時は燃焼室内に設けた点火プラグにより燃焼室内の混合気を火花点火して燃焼させ、圧縮自己着火運転時はピストンの圧縮作用により燃焼室内の混合気を自己着火して燃焼させる圧縮自己着火式ガソリン内燃機関において、前記燃焼室よりも容積の小さな副室を設け、この副室と前記燃焼室とを、副室の断面積よりも小さな開口面積に形成された噴口により連通させ、前記副室に副室用点火プラグを設けたことを特徴とする圧縮自己着火式ガソリン内燃機関。

【請求項２】　圧縮自己着火運転時に、副室用点火プラグを点火させることを特徴とする請求項１記載の圧縮自己着火式ガソリン内燃機関。

【請求項３】　高負荷運転時に、燃焼室内の濃度分布を均一に構成した状態で、副室用点火プラグを点火させた後、燃焼室内の点火プラグを点火させることを特徴とする請求項１または２記載の圧縮自己着火式ガソリン内燃機関。

【請求項４】　高負荷運転時に、燃焼室内の濃度分布を不均一に構成した状態で、燃焼室内の点火プラグを点火させた後、副室用点火プラグを点火させることを特徴とする請求項１または２記載の圧縮自己着火式ガソリン内燃機関。内燃機関。

【請求項５】　機関の実圧縮比は、自己着火発生を促す補助手段によっても自己着火しない値に設定されていることを特徴とする請求項１ないし４のいずれかに記載の圧縮自己着火式ガソリン内燃機関。

【請求項６】　機関の実圧縮比は、補助手段の設定値あるいは複数の補助手段の組合せによっては自己着火しない値に設定されていることを特徴とする請求項５記載の圧縮自己着火式ガソリン内燃機関。

【請求項７】　補助手段の状態を検出するセンサを設け、このセンサの検出信号の入力を受けて次サイクルの燃焼反応を制御する制御手段を設けたことを特徴とする請求項５または６記載の圧縮自己着火式ガソリン内燃機関。

【請求項８】　ノッキングあるいは急速燃焼に基づく異常音が発生した場合には、副室用点火プラグおよび燃焼室内の点火プラグの各点火時期間隔を大きくすることを特徴とする請求項１ないし７のいずれかに記載の圧縮自己着火式ガソリン内燃機関。

【請求項９】　ノッキングあるいは急速燃焼に基づく異常音を検出するセンサを設け、このセンサの検出信号に基づいて副室用点火プラグおよび燃焼室内の点火プラグの各点火時期を制御する制御手段を設けたことを特徴とする請求項８記載の圧縮自己着火式ガソリン内燃機関。

【請求項１０】　燃焼室内に燃料を噴射する燃料噴射弁を設け、副室の噴口を、前記燃料噴射弁からの燃料噴霧が圧縮行程でピストン冠面に沿って指向する方向に配置するとともに、ピストン冠面に沿って横長形状となる燃料噴霧の形状に対応して横長形状に形成したことを特徴とする請求項１ないし９のいずれかに記載の圧縮自己着火式ガソリン内燃機関。

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【請求項１１】　燃焼室内に燃料を噴射する燃料噴射弁を設け、副室の噴口を、前記燃料噴射弁からの燃料噴霧が圧縮行程でピストン冠面に沿って指向する方向に配置するとともに、ピストン冠面に沿って横長形状となる燃料噴霧の形状に対応して複数形成したことを特徴とする請求項１ないし９のいずれかに記載の圧縮自己着火式ガソリン内燃機関。

【請求項１２】　噴口の中心を副室の中心に対して偏心させたことを特徴とする請求項１ないし１１のいずれかに記載の圧縮自己着火式ガソリン内燃機関。

【請求項１３】　副室と燃焼室とを連通する第２の噴口を、燃焼室内の点火プラグに対向するよう設けたことを特徴とする請求項１ないし１２のいずれかに記載の圧縮自己着火式ガソリン内燃機関。

【請求項１４】　点火プラグと副室用点火プラグとは、イグニッションコイルを共用し、このイグニッションコイルの二次側に切替スイッチを設けたことを特徴とする請求項１ないし１３のいずれかに記載の圧縮自己着火式ガソリン内燃機関。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、火花点火運転時は燃焼室内に設けた点火プラグにより燃焼室内の混合気を火花点火して燃焼させ、圧縮自己着火運転時はピストンの圧縮作用により燃焼室内の混合気を自己着火して燃焼させる圧縮自己着火式ガソリン内燃機関に関する。

【０００２】

【従来の技術】ガソリン内燃機関の熱効率向上手段として、混合気のリーン化が挙げられるが通常の火花点火と火炎伝播による燃焼では、燃焼が不安定となってリーン化にも自ずと限界が生じてしまうことと、リーン燃焼時には排気浄化のための触媒がいわゆる量論比での燃焼時ほど浄化性能、特にＮＯx の還元性能を発揮できなくなってしまうため、このリーン燃焼の運転可能な負荷範囲の拡大と低ＮＯx 化を目的として、機関の低中負荷時等に燃焼室内の混合気をピストンの圧縮作用により自己着火燃焼させるようにした圧縮自己着火燃焼式のガソリン内燃機関が知られている。

【０００３】ところで、圧縮自己着火式ガソリン内燃機関における最大の課題は、自己着火開始時期を最適に制御することであり、例えば特開平１１－２１０５３９号公報には、吸気ポートに設置した温度センサにより燃焼室内の温度を検出して、ＥＧＲガス量を制御したり、吸気弁の開弁時期を制御することで、燃焼室内のガス温度を、点火プラグによりアシスト点火すると自己着火を生ずる温度に維持するようにしている。

【０００４】

【発明が解決しようとする課題】しかしながら、このような構成では、たとえ吸気ポートに設置した温度センサにより圧縮上死点近傍のガス温度が予測できたとしても、燃焼室内の空間温度には分布が生じるので、燃焼室内のガス温度を正確に求めることはできない。すなわち、シリンダ壁やシリンダヘッド壁あるいはピストン冠面などはガス温度より当然低いため、自己着火を促すアシスト点火を行っても、それによる自己着火の進行すなわち熱発生あるいは圧力上昇率、反応速度などは制御しきれない。

【０００５】この結果、圧縮上死点付近での筒内圧力および温度が一様に高まる恐れがあり、圧縮自己着火燃焼が一斉に生じるいわゆる急速燃焼が起こり、圧力上昇率が著しく高くなって打音を発生し、これが騒音となって商品性にも大きく悪影響を与える。

【０００６】また、燃焼室内ではその周壁面付近で冷却により温度が低くなるため燃焼室全体の温度が不均一になり、混合気も燃焼室全体で均一になることはないため、圧縮自己着火燃焼の開始時期が燃焼場の自己着火条件の整、不整によって変動し、燃焼が不安定となってサイクル毎の出力変動を来す可能性がある。

【０００７】圧縮自己着火燃焼のような化学反応は燃焼室内の圧力，温度，混合気の組成と濃度等に依存しており、ディーゼル機関と異なりセタン価が低く着火性の悪いガソリンを燃料として用いるガソリン内燃機関では、圧縮自己着火燃焼を成立させる１つの手法として、圧縮比を高く設定することと併せて、燃焼室内の温度を高く維持して混合気の活性化を促進するために、吸，排気バルブのバルブオーバーラップを大きく設定することにより高温の既燃ガスを大量に残留させていわゆる内部ＥＧＲ率を高める等の手段を講じる必要がある。

【０００８】ところが、高圧縮比，高内部ＥＧＲ率に設定した場合には、上記した急速燃焼が生じるほかに、空燃比の希薄限界やノッキング限界を生じて、圧縮自己着火燃焼の運転可能領域を狭めたり、火花点火燃焼を行わせる高回転・高負荷域の運転性能の悪化をもたらす。

【０００９】そこで、この発明は、圧縮自己着火燃焼を多段的な熱発生の形態をとる調速燃焼として燃焼時の打音発生を回避しかつ、圧縮比および内部ＥＧＲ率を可及的に低減できて圧縮自己着火運転領域を拡大できるとともに火花点火運転域でのノッキング発生を抑制でき、しかも、圧縮自己着火の開始時期を確定できて燃焼を安定化させることを目的としている。

【００１０】

【課題を解決するための手段】前記目的を達成するために、請求項１の発明は、火花点火運転時は燃焼室内に設けた点火プラグにより燃焼室内の混合気を火花点火して燃焼させ、圧縮自己着火運転時はピストンの圧縮作用により燃焼室内の混合気を自己着火して燃焼させる圧縮自己着火式ガソリン内燃機関において、前記燃焼室よりも容積の小さな副室を設け、この副室と前記燃焼室とを、副室の断面積よりも小さな開口面積に形成された噴口により連通させ、前記副室に副室用点火プラグを設けた構成としてある。

【００１１】このような構成の圧縮自己着火式ガソリン内燃機関によれば、燃焼室と副室とを連絡する噴口は副室断面積よりも小さい開口面積であることから、副室内は充分な掃気がなされず、残留ガスが残る温度の高い空間となり、このため噴口を通じて副室に流入する混合気は、燃焼室よりも温度の高い、すなわち反応しやすいラジカルを生成する。このため、これまで、燃焼室内全域で圧縮自己着火を発生させるために上げていた、平均圧縮比および内部ＥＧＲ率は下げられ、副室内のラジカルは急速にここで生成され、自己着火のトリガー空間が準備される。

【００１２】そして、副室用点火プラグにより副室内を点火すると、さらに多量のラジカルが生成され、副室内の温度が上昇する。点火時期は、熱効率のよい熱発生期間とするのが望ましく、このようにして生成される副室内ラジカルは噴口を通じて燃焼室側へと噴出する。副室からの燃焼室へのラジカル噴流により、強い剪断流れが生じ、既燃ガスと未燃ガスが混じりつつ反応が進行して火炎伝播よりも早い燃焼反応が燃焼室内で誘起され、自己着火の進行が促進される。

【００１３】このような噴口から燃焼室へ噴出するラジカルをトリガーとした自己着火燃焼は、燃焼室内の全域で一斉蜂起的に発生する自己着火燃焼と異なって多段的な熱発生の形態をとる調速燃焼となり、これにより燃焼時の打音発生が回避される。

【００１４】請求項２の発明は、請求項１の発明の構成において、圧縮自己着火運転時に、副室用点火プラグを点火させる構成としてある。

【００１５】上記構成によれば、圧縮自己着火運転時に、副室用点火プラグを点火させることで、自己着火のトリガーとなる反応の開始を副室内で発現する。

【００１６】請求項３の発明は、請求項１または２の発明の構成において、高負荷運転時に、燃焼室内の濃度分布を均一に構成した状態で、副室用点火プラグを点火させた後、燃焼室内の点火プラグを点火させる構成としてある。

【００１７】副室の位置は壁温や直噴を想定した場合にも排気系になる構成が現実的である。燃焼室にある点火プラグはシリンダ軸に近い燃焼室中心近傍となるが、この点火プラグによる伝播火炎は一般的に排気側空間への伝播が吸気側空間よりも早いことが判っている。これは伝播火炎が温度の高い排気側壁面ではクエンチされにくいためである。この結果、高負荷運転時における伝播火炎によるノッキングのトリガーとなる自己着火は吸気側で発生しやすい。したがって副室用点火プラグの点火をまず行い、高速の噴流を燃焼室に吹き出して吸気側混合

気の燃焼を行わせ、次に中心にある燃焼室側点火プラグによる伝播火炎により、ノッキングを抑制しつつ燃焼室内全体を燃焼させる。

【００１８】請求項４の発明は、請求項１または２の発明の構成において、高負荷運転時に、燃焼室内の濃度分布を不均一に構成した状態で、燃焼室内の点火プラグを点火させた後、副室用点火プラグを点火させる構成としてある。

【００１９】例えば、燃焼室を直噴構成とし、燃料噴射時期を圧縮行程とすれば高負荷運転においても成層燃焼が可能であり、これにより混合気濃度の不均一空間を形成できる。燃焼室内の濃度分布が不均一の場合には、全体の空燃比が当量比１であっても、燃焼室内にはこれよりも濃い空間と薄い空間が存在する。このような不均一空間に副室からの点火による噴流を吹き出すことで、過濃混合気のもとで形成されやすい煤を擾乱させて酸化させることが可能となる。

【００２０】請求項５の発明は、請求項１ないし４のいずれかの発明の構成において、機関の実圧縮比は、自己着火発生を促す補助手段によっても自己着火しない値に設定されている。

【００２１】上記構成によれば、機関の実圧縮比は圧縮によって自己着火反応を誘起させる必要がないため、点火以外のいかなる自己着火を促す補助手段によっても反応が開始しない低圧縮比に設定できる。

【００２２】請求項６の発明は、請求項５の発明の構成において、機関の実圧縮比は、補助手段の設定値あるいは複数の補助手段の組合せによっては自己着火しない値に設定されている。

【００２３】上記構成によれば、副室内での副室用点火プラグの点火による燃焼室内の自己着火が容易となる。

【００２４】請求項７の発明は、請求項５または６の発明の構成において、補助手段の状態を検出するセンサを設け、このセンサの検出信号の入力を受けて次サイクルの燃焼反応を制御する制御手段を設けた構成としてある。

【００２５】上記構成によれば、センサによって補助手段のサイクル毎の状態を検出し、次サイクルの点火時期を適宜変更して反応を制御する。

【００２６】請求項８の発明は、請求項１ないし７のいずれかの発明の構成において、ノッキングあるいは急速燃焼に基づく異常音が発生した場合には、副室用点火プラグおよび燃焼室内の点火プラグの各点火時期間隔を大きくする構成としてある。

【００２７】点火プラグの点火をトリガーとした伝播火炎の発現は、時間的に一義的にできる。一方、その後の反応進行速度があまりに速いと、急激な圧力上昇を起こし、伝播火炎の燃焼終了域において一気に反応が進行して終了し、ノッキングを招く。そこで、このような場合に、二つの点火プラグの点火時期間隔を大きくすることで、ノッキングあるいは急速燃焼に基づく異常音を回避する。

【００２８】請求項９の発明は、請求項８の発明の構成において、ノッキングあるいは急速燃焼に基づく異常音を検出するセンサを設け、このセンサの検出信号に基づいて副室用点火プラグおよび燃焼室内の点火プラグの各点火時期を制御する制御手段を設けた構成としてある。

【００２９】上記構成によれば、ノッキングや異常音発生時に、燃焼室に設けた圧力センサやシリンダブロックに設けた振動センサにより、これを検知して、次サイクルの副室用点火プラグおよび燃焼室内点火プラグの各点火時期を適切とすることにより、ノッキングや異常音を抑える。

【００３０】請求項１０の発明は、請求項１ないし９のいずれかの発明の構成において、燃焼室内に燃料を噴射する燃料噴射弁を設け、副室の噴口を、前記燃料噴射弁からの燃料噴霧が圧縮行程でピストン冠面に沿って指向する方向に配置するとともに、ピストン冠面に沿って横長形状となる燃料噴霧の形状に対応して横長形状に形成してある。

【００３１】上記構成によれば、圧縮行程で燃料噴射弁から噴射された燃料がピストン冠面に沿って流れ、噴口を経て副室内に効率よく入り込み、その後副室用点火プラグの点火により生成される副室内の大量のラジカルを含んだガスは、噴口を逆流して燃焼室内の混合気中の広い範囲にわたり流れ込む。

【００３２】請求項１１の発明は、請求項１ないし９のいずれかの発明の構成において、燃焼室内に燃料を噴射する燃料噴射弁を設け、副室の噴口を、前記燃料噴射弁からの燃料噴霧が圧縮行程でピストン冠面に沿って指向する方向に配置するとともに、ピストン冠面に沿って横長形状となる燃料噴霧の形状に対応して複数形成している。

【００３３】上記構成によれば、圧縮行程で燃料噴射弁から噴射された燃料がピストン冠面に沿って流れ、複数の噴口を経て副室内に効率よく入り込み、その後副室用点火プラグの点火により生成される副室内の大量のラジカルを含んだガスは、複数の噴口を逆流して燃焼室内の混合気中の広い範囲にわたり流れ込む。

【００３４】請求項１２の発明は、請求項１ないし１１のいずれかの発明の構成において、噴口の中心を副室の中心に対して偏心させた構成としてある。

【００３５】上記構成によれば、ピストンの圧縮により燃焼室内の混合気が噴口を通って副室内に流入すると、副室内では渦流が発生して混合気は副室の最深部まで到達する。

【００３６】請求項１３の発明は、請求項１ないし１２のいずれかの発明の構成において、副室と燃焼室とを連通する第２の噴口を、燃焼室内の点火プラグに対向するよう設けた構成としてある。

【００３７】上記構成によれば、副室内で点火により生成されたラジカルが燃焼室内の点火プラグに向けて噴出する。また、副室用点火プラグが点火する前に燃焼室内点火プラグが点火した場合の燃焼室内のラジカルが、第２の噴口を設けることにより副室に流入しやすくなる。

【００３８】請求項１４の発明は、請求項１ないし１３のいずれかの発明の構成において、点火プラグと副室用点火プラグとは、イグニッションコイルを共用し、このイグニッションコイルの二次側に切替スイッチを設けた構成としてある。

【００３９】上記構成によれば、切替スイッチを切り替えることにより、燃焼室内の点火プラグと副室用点火プラグとのいずれかが点火される状態となる。

【００４０】

【発明の効果】請求項１の発明によれば、圧縮自己着火式ガソリン内燃機関において、燃焼室よりも容積の小さな副室と燃焼室とを、副室の断面積よりも小さな開口面積に形成した噴口により連通させ、前記副室に副室用点火プラグを設けた構成としたため、副室内は充分な掃気がなされず、残留ガスが残る温度の高い空間となり、このため噴口を通じて副室に流入する混合気は、燃焼室よりも温度の高い反応しやすいラジカルを生成でき、これまで、燃焼室内全域で圧縮自己着火を発生させるために上げていた、平均圧縮比および内部ＥＧＲ率を下げることができる。また、混合気が流入した副室内は、自己着火のトリガー空間となり、ここで副室用点火プラグを点火することで、さらに多量のラジカルが生成されて温度上昇し、この副室内ラジカルは噴口を通じて燃焼室側へと噴出し、既燃ガスと未燃ガスが混じりつつ、自己着火の進行を促進させることができる。さらに、このような噴口から噴出するラジカルをトリガーとした自己着火燃焼は、燃焼室内の全域で一斉蜂起的に発生する自己着火燃焼と異なって多段的な熱発生の形態をとる調速燃焼となり、これにより燃焼時の打音発生を回避することができる。

【００４１】請求項２の発明によれば、圧縮自己着火運転時に、副室用点火プラグを点火させるようにしたため、圧縮自己着火運転状態となった場合に、圧縮自己着火のトリガーとなる反応の開始を副室内で発現させることができる。

【００４２】請求項３の発明によれば、高負荷運転時に、燃焼室内の濃度分布を均一に構成した状態で、副室用点火プラグを点火させた後、燃焼室内の点火プラグを点火させるようにしたため、副室用点火プラグの点火により、副室から高速の噴流が燃焼室に吹き出し、次に燃焼室側点火プラグの点火に基づく伝播火炎により、ノッキングを抑制しつつ燃焼室内全体を燃焼させることができる。

【００４３】請求項４の発明によれば、高負荷運転時に、燃焼室内の濃度分布を不均一に構成した状態で、燃焼室内の点火プラグを点火させた後、副室用点火プラグを点火させるようにしたため、副室から燃焼室に吹き出す噴流により、燃焼室内の過濃混合気のもとで形成されやすい煤を攪乱させて酸化させることができる。

【００４４】請求項５の発明によれば、機関の実圧縮比は、自己着火発生を促す補助手段によっても自己着火しない値に設定されているため、点火以外のいかなる自己着火を促す補助手段によっても反応が開始しない低圧縮比に設定することができる。

【００４５】請求項６の発明によれば、機関の実圧縮比は、補助手段の設定値あるいは複数の補助手段の組合せによっては自己着火しない値に設定されているため、低圧縮比に設定できる上、副室用点火プラグの点火による反応の発現をトリガーとした燃焼室内の自己着火燃焼を容易に行わせることができる。

【００４６】請求項７の発明によれば、補助手段の状態を検出するセンサを設け、このセンサの検出信号の入力を受けて次サイクルの燃焼反応を制御する制御手段を設けたため、サイクル毎の燃焼変動を防止でき、安定した自己着火燃焼を行わせることができる。

【００４７】請求項８の発明によれば、ノッキングあるいは急速燃焼に基づく異常音が発生した場合には、副室用点火プラグおよび燃焼室内の点火プラグの各点火時期間隔を大きくするようにしたため、燃焼速度が制御されてノッキングあるいは急速燃焼に基づく異常音を抑制することができる。

【００４８】請求項９の発明によれば、ノッキングあるいは急速燃焼に基づく異常音を検出するセンサの検出信号に基づいて、副室用点火プラグおよび燃焼室内の点火プラグの各点火時期を制御する制御手段を設けたため、ノッキングや異常音をセンサにより検知して、次サイクルの副室用点火プラグおよび燃焼室内点火プラグの点火時期間隔や点火有無判断を適切とすることにより、ノッキングや異常音を抑えることができる。

【００４９】請求項１０の発明によれば、燃焼室内に燃料を噴射する燃料噴射弁を設け、副室の噴口を、前記燃料噴射弁からの燃料噴霧が圧縮行程でピストン冠面に沿って指向する方向に配置するとともに、ピストン冠面に沿って横長形状となる燃料噴霧の形状に対応して横長形状に形成したため、圧縮行程で燃料噴射弁から噴射された燃料噴霧がピストン冠面を沿って流れ噴口から副室内に効率よく入り込み、その後副室用点火プラグの点火により生成される副室内の大量のラジカルを含んだガスが、横長形状の噴口から燃焼室内の混合気の広い範囲にわたって流れ込み、反応の促進に寄与することができる。

【００５０】請求項１１の発明によれば、燃焼室内に燃料を噴射する燃料噴射弁を設け、副室の噴口を、前記燃料噴射弁からの燃料噴霧が圧縮行程でピストン冠面に沿って指向する方向に配置するとともに、ピストン冠面に

沿って横長形状となる燃料噴霧の形状に対応して複数形成したため、圧縮行程で燃料噴射弁から噴射された燃料噴霧がピストン冠面を沿って流れ複数の噴口から副室内に効率よく入り込み、その後副室用点火プラグの点火により生成される副室内の大量のラジカルを含んだガスが、複数の噴口から燃焼室内の混合気の広い範囲にわたって流れ込み、反応の促進に寄与することができる。

【００５１】請求項１２の発明によれば、噴口の中心を副室の中心に対して偏心させたため、ピストンの圧縮により燃焼室から噴口を通って副室内に流入する混合気は、副室内で渦流となって副室の最深部まで到達し、副室内用点火プラグの点火を確実行わせることができる。

【００５２】請求項１３の発明によれば、副室と燃焼室とを連通する第２の噴口を、燃焼室内の点火プラグに対向するよう設けたため、副室内で点火により生成されたラジカルが燃焼室内の点火プラグに向けて噴出し、点火プラグによる点火を確実に行わせることができる。また、燃焼室内点火プラグの点火による燃焼室内のラジカルが、第２の噴口を設けることにより副室に流入しやすくなる。

【００５３】請求項１４の発明によれば、点火プラグと副室用点火プラグとは、イグニッションコイルを共用し、このイグニッションコイルの二次側に切替スイッチを設けたため、２つの点火プラグに対応して２つの点火系統を設ける必要がなくなり、部品点数の削減に寄与できる。

【００５４】

【発明の実施の形態】以下、この発明の実施の形態を図面に基づき説明する。

【００５５】図1は、この発明の実施の一形態を示す圧縮自己着火式ガソリン内燃機関の全体構成図で、シリンダ1内にピストン３が上下動可能に収容され、燃焼室５に連通する吸気ポート７および排気ポート９には、吸気バルブ１１およびび排気バルブ１３がそれぞれ設けられている。吸気バルブ１１およびび排気バルブ１３は、図１中で紙面に直交する方向にそれぞれ２つ設けられ、これにより燃焼室5はペントルーフ型を構成している。

【００５６】燃料供給系は、吸気ポート噴射の場合と直噴の場合とを併記しており、本実施例ではいずれを用いてもよい。つまり、吸気ポート噴射の場合には低圧燃料噴射弁１５を設ける構成として、この燃料噴射弁１５により燃料を吸気ポート７に噴射し、直噴の場合には高圧燃料噴射弁１７を設ける構成として、この燃料噴射弁１７により燃焼室５に直接燃料を噴射供給する。

【００５７】なお、以後の説明で、燃料噴射時期が圧縮行程にある場合（Late噴射）あるいは成層燃焼の場合は、直噴構成を前提としている。また、均一予混合燃焼の場合は、吸気ポート噴射構成を前提としている。しかしながら、直噴構成であっても、吸気行程噴射であれば、均一予混合燃焼となる。

【００５８】ペントルーフ型の燃焼室５の中央に、点火プラグ１９が設置され、この点火プラグ１９の近傍で二つの排気ポート９相互間に、燃焼室５よりも容積の小さい副室２１が設けられている。これは、直噴構成を想定した場合に、吸気バルブ１１側に設置した燃料噴射弁１７により、排気バルブ１３側に向けて燃料噴霧を噴射するためであり、また副室２１内を壁温の高い状態に確保するためでもある。副室２１と燃焼室５とは、副室２１の断面積よりも小さな開口面積に形成された噴口２２により連通している。

【００５９】そして、副室２１の最深部付近には、副室用点火プラグ２３が設けられている。この副室用点火プラグ２３は、負荷の高い運転条件においては、基本的に使用しないので、通常の点火プラグ１９より小さくてよく、また電極劣化を留意した材質や構造、絶縁破壊対策やスパークギャップ長さ、周辺の冷却の程度などを、通常の点火プラグ１９ほど考慮する必要がない。

【００６０】燃焼室５内の点火プラグ１９および副室用点火プラグ２３には、イグニッションコイルなどを備えた点火系２５および２７がそれぞれ接続され、これら各点火系２５，２７は、制御手段としての電子制御ユニット２９によって点火制御される。この電子制御ユニット２９には、さらに、機関回転数センサ３１、負荷センサ３３および水温センサ３５の各検出値が入力される。

【００６１】また、電気制御ユニット２９には、機関回転数、機関負荷、暖機状態を示す水温と、点火プラグ１９および副室用点火プラグ２３の点火形態との関係を示すテーブルが格納されている。そして、電子制御ユニット２９は、前記各種センサの検出値の入力を受けて運転条件を把握し、点火プラグ１９と副室用点火プラグ２３とのいずれ、あるいは両方を点火するか否かを判断する。

【００６２】図２は、上記した電子制御ユニット２９による各点火プラグ１９，２３の点火制御動作を示すフローチャートである。機関の運転状態が高負荷で（ステップ２０１）、かつ暖機状態で（ステップ２０３）、さらに圧縮自己着火運転状態の場合には（ステップ２０５）、副室用点火プラグ２３を点火する（ステップ２０７）。

【００６３】圧縮自己着火運転は、図３に示すように、曲線ａより低回転、低負荷側の領域（Ａ）とする。なお、図３において、曲線ａと曲線ｂとで囲まれた領域（Ｂ）は成層火花点火領域、曲線ｂと破線ｃとで囲まれた領域（Ｂ）’は均一リーンバーン火花点火領域、曲線ｂと曲線ｄとで囲まれた領域（Ｃ）は均一ストイキ（理論混合比）火花点火領域である。

【００６４】副室用点火プラグ２３の点火時期は、図４に示すように、機関回転数が高くなるほど、また機関負荷が低くなるほど、進角させる。機関回転数が高くなると、クランク角度では同じ反応期間でも、実反応時間は

短くなっているはずである。このため、効率のよい熱発生時期（点火燃焼でのＭＢＴに該当する）を得るためには、高回転になるほど点火時期を早める必要がある。また、機関負荷が高くなると、より多くの燃料を供給することが必要となるので、反応に伴う圧力上昇率はより急激となり、ノックと同様な不快感のある音や機関にダメージを与える急激な熱発生により、燃焼室５を構成している部位の溶損につながる。これを回避するには熱発生時期を遅らせることが必要であり、したがって機関負荷が高くなると点火時期を遅らせることになる。

【００６５】燃焼室５と副室２１とを連絡する噴口２２は副室２１の断面積よりも小さい開口面積であることから、排気行程にて副室２１内は充分な掃気がなされず、残留ガスが残る温度の高い空間となり、この状態で圧縮行程にて噴口２２を通じて副室２１に流入する混合気は、燃焼室５よりも温度の高い、すなわち反応しやすいラジカルを生成する。このため、これまで、燃焼室５内全域で圧縮自己着火を発生させるために上げていた、平均圧縮比および内部ＥＧＲ率は下げられ、副室２１内のラジカルは急速にここで生成され、自己着火のトリガー空間が準備される。

【００６６】上記した機関の実圧縮比は、自己着火発生を促す補助手段、例えば吸気温度加熱手段、残留ガス量増加手段、空燃比などを利用しても自己着火しない値に設定されており、これにより、副室用点火プラグ２３の火花点火をトリガーとして自己着火を発生させることが可能となっている。また、機関の実圧縮比としては、上記補助手段の設定値あるいは複数の補助手段の組み合わせによっては、自己着火しない値に設定してもよい。これにより、副室用点火プラグ２３の火花点火による自己着火が発生しやすいものとなる。

【００６７】副室用点火プラグ２３が点火されると、さらに多量のラジカルが生成され、副室２１内の温度が上昇する。このようにして生成される副室２１内ラジカルは噴口２２を通じて燃焼室５側へと噴出する。副室２１からの燃焼室５へのラジカルの噴流により、強い剪断流れが生じ、既燃ガスと未燃ガスが混じりつつ反応が進行して火炎伝播よりも早い燃焼反応が燃焼室内で誘起され、自己着火の進行が促進される。

【００６８】このような噴口２２から噴出するラジカルをトリガーとした自己着火燃焼は、燃焼室５内の全域で一斉蜂起的に発生する自己着火燃焼と異なって多段的な熱発生の形態をとる調速燃焼となり、これにより燃焼時の打音発生が回避される。

【００６９】図５は、副室用点火プラグ２３の点火による反応速度を示す指圧線図である。これによれば、最初に副室２１内での点火による熱発生が起こり、この熱発生と圧力上昇はモータリング波形に圧力増分を上乗せした程度であるが、これにより燃焼室５内の圧力は上昇する。このことにより、燃焼室５内の空燃比が可燃空燃比外の希薄側にあっても、反応しやすくなり、最終的には副室２１からのラジカル供給によって反応する。結果として点火によってサイクル毎の変動が少ない熱発生期間すなわち出力が得られる。

【００７０】前記ステップ２０３で未暖機と判断された場合と、ステップ２０５で圧縮自己着火運転ではないと判断された場合には、副室用点火プラグ２３を点火せず、燃焼室５内の点火プラグ１９を点火させ（ステップ２０９）、通常の伝播火炎による燃焼を行わせる。

【００７１】また、図１の構成では、吸気ポート７に吸気温センサ３７を設けて図示しない吸気加熱手段による吸気加熱状態を検知できるようにし、またバルブオーバラップを可変にできる可変動弁機構３８にカム作動角センサ３９を設けて残留ガス量変化を検知できるようにし、さらに排気管４１に設けた触媒４３の上流に空燃比センサ（O_2センサ）４５を設置して空燃比を検知できるようにしてある。これにより、サイクル毎の燃焼状態を把握し、その反応の程度によって次サイクルの反応を制御することができ、自己着火燃焼をサイクル毎に変動なく行わせることが可能となる。

【００７２】前記図２におけるステップ２０１で機関が高負荷であると判断された場合には、均一予混合による燃焼かどうかを判断するが、ここでは直噴構成を考慮しており、したがってLate噴射かどうかを判断する（ステップ２１１）。Late噴射と判断された場合には、最初に燃焼室５内の点火プラグ１９を点火し（ステップ２１３）、続いて副室用点火プラグ２３を点火する（ステップ２１５）。高負荷運転状態においてLate噴射では、点火プラグ１９および副室用点火プラグ２３の近傍の燃料が濃くなっている。したがって空燃比が４０のような、可燃空燃比より薄い条件にあっても各点火プラグ１９，２３近傍の空間については可燃空燃比にある。

【００７３】この場合、噴射燃料を適当な期間にすべて燃焼させれば、出力と排気の両立が図れる。しかし、過濃混合比下では酸素不足の燃焼が存在しうる。これはＨＣ、煤、ＣＯなどの排気悪化を引き起こす。これを回避するためには、過濃空燃比とそれ以外の空間にある酸素との混合をタイミングよく行わせる必要がある。このために、燃焼室５内の点火に遅れて副室２１内の点火を行わせ、副室２１内での点火後の副室２１からの噴出火炎により、燃焼室５内を撹乱させ、混合を促進させ、これにより排気性能、特にＮＯｘや煤発生が抑制され、高負荷運転要求の出力との両立が図れる。

【００７４】熱発生期間は、出力の得られる有効な時期と期間に行われるべきであり、回転数の上昇に伴っても両点火プラグの点火時期差はクランク角度で大きくは変わらないはずである。図６は、機関回転数に対する二つの点火プラグの点火時期を示すもので、燃焼室５内の点火プラグ１９の点火時期を実線で、副室用点火プラグ２３の点火時期を破線でそれぞれ示す。

【００７５】前記ステップ２１１でLate噴射でないと判断された場合には、副室用点火プラグ２３から点火し（ステップ２１７）、副室２１からの噴出火炎により、噴口２２が指向する燃焼室５内の吸気系側空間を最初に燃焼させる。次に、燃焼室５内の点火プラグ１９の点火（ステップ６０９）による伝播火炎により、燃焼室５内の残りの空間の燃焼が行われる。点火プラグ１９の点火による燃焼室５内における燃焼空間が狭まるので燃焼期間が短くなり、また燃焼室５の吸気側空間が先に燃焼を終えるのでノッキング発生を抑制あるいは軽微とすることができる。

【００７６】図７は、副室用点火プラグ２３の点火の後に燃焼室５内の点火プラグ１９を点火させる場合の、機関回転数に対する点火時期を示すもので、燃焼室５内の点火プラグ１９の点火時期を実線で、副室用点火プラグ２３の点火時期を破線でそれぞれ示している。

【００７７】図８は、この発明の他の実施の形態を示している。この実施の形態は、機関の振動を検出する振動センサ４７を付加しており、この場合の制御動作を図９に示している。この場合は、前記図２のステップ２０１において、機関の運転状態がが高負荷であると判断された場合に、振動センサ４７の検出値の入力を受けてノッキングあるい急速燃焼に基づく異常音が発生したかどうかが判断される（ステップ９０１）。ここで、ノッキングあるいは異常音が発生した場合には、燃焼室５内の点火プラグ１９の点火時期Igmと、副室用点火プラグ２３の点火時期Igsとの差｜Igm－Igs｜を大きくした状態で（ステップ９０３）、燃焼室５内の点火プラグ１９（副室用点火プラグ２３）の点火（ステップ９０５）に続いて副室用点火プラグ２３（点火プラグ１９）の点火を行う（ステップ９０７）。

【００７８】逆に、ノッキングあるいは異常音が発生していない場合には、燃焼室５内の点火プラグ１９の点火時期Igmと、副室用点火プラグ２３の点火時期Igsとの差｜Igm－Igs｜を小さくした状態で（ステップ９０９）、燃焼室５内の点火プラグ１９（副室用点火プラグ２３）の点火（ステップ９０５）に続いて副室用点火プラグ２３（点火プラグ１９）の点火を行う（ステップ９０７）。

【００７９】点火プラグの点火をトリガーとした伝播火炎の発現は、時間的に一義的にできる。一方、その後の反応進行速度があまりに速いと、急激な圧力上昇を起こし、伝播火炎の燃焼終了域において一気に反応が進行して終了し、ノッキングを招く。そこで、このような場合に、二つの点火プラグ１９，２３の点火時期間隔を大きくすることで、ノッキングあるいは急速燃焼に基づく異常音を回避することができる。

【００８０】また、上記図８においては、点火プラグ１９と副室用点火プラグ２３とは、イグニッションコイルを備えた点火系を例えば点火系２５の一つとし、この点火系２５の二次側に切替スイッチ４９を設け、切替スイッチ４９により二つの点火プラグ１９，２３を切り替えるようにしている。これにより、２つの点火プラグ１９，２３に対応して２つの点火系統を設ける必要がなくなり、部品点数の削減に寄与できる。

【００８１】図１０は、図１のＡ矢視図で、噴口２２の形状を示している。この噴口２２は、図１中で紙面に直交する方向、すなわちペントルーフの尾根線に沿う方向に長い長円形としてある。これは、Late噴射の場合に、図１に示してあるように、高圧燃料噴射弁１７からの燃料噴霧は、ピストン冠面に沿いながら、燃焼室５内の点火プラグ１９や噴口２２が臨む空間へと上昇する構成となっている。噴射形状が噴射弁軸対称であってもピストン冠面を沿う時点で横長形状となるため、この横長形状の噴霧を、上記した長円形の噴口２２が効率よく副室２１内に取り込む。また、副室用点火プラグ２３の点火により生成される副室２１内の大量のラジカルを含んだガスが、横長形状の噴口２２から燃焼室５内の混合気の広い範囲にわたって流れ込み、反応の促進に有効となる。

【００８２】図１１は、噴口２２を図１０の長円形に代えて、小円形の噴口２２ａを長円形の長軸方向に沿って複数設けた例を示している。

【００８３】図１２は、噴口２２の中心を副室２１の中心に対して偏心させた例を示している。この場合の噴口２２は長円形でも円形でも構わない。この例では、ピストン３の圧縮により燃焼室５内の混合気が噴口２２を通って副室２１内に流入すると、副室２１内では渦流が発生して混合気は副室２１の最深部まで到達する。これにより、副室内用点火プラグ２３の点火を確実に行わせることができる。

【００８４】図１３は、図１２の構成に加え、副室２１と燃焼室５とを連通する第２の噴口５１を、燃焼室５内の点火プラグ１９のスパークギャップに対向するよう設けた例である。これにより、副室２１内で点火により生成されたラジカルが燃焼室５内の点火プラグ１９のスパークギャップに向けて噴出し、点火プラグ１９による点火を確実に行わせることができる。また、副室用点火プラグ２３が点火する前に燃焼室５内の点火プラグ１９が点火した場合の燃焼室５内のラジカルが、第２の噴口５１を設けることにより副室２１に流入しやすくなる。

【図面の簡単な説明】

【図１】この発明の実施の一形態を示す圧縮自己着火式ガソリン内燃機関の全体構成図である。

【図２】図１の圧縮自己着火式ガソリン内燃機関における電子制御ユニットによる各点火プラグの点火制御動作を示すフローチャートである。

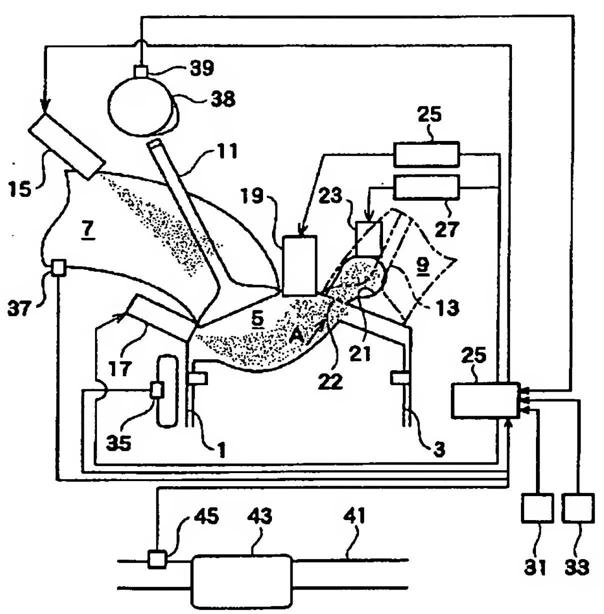
【図３】各種燃焼形態を機関回転数と機関負荷との関係で示した説明図である。

【図４】図３における圧縮自己着火運転における点火時期を機関回転数と機関負荷との関係で示した説明図であ

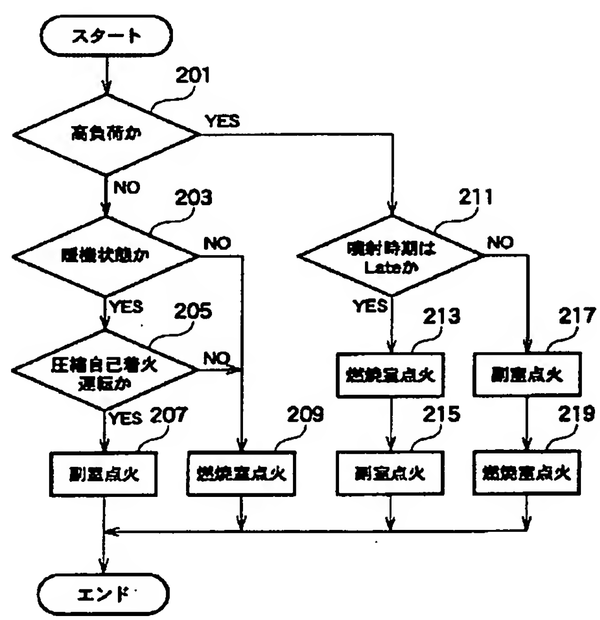
る。
【図５】図１の圧縮自己着火式ガソリン内燃機関における副室用点火プラグの点火による反応状態を示す指圧線図である。
【図６】燃焼室点火に続いて副室点火を行った場合の機関回転数に対する点火時期特性図である。
【図７】副室点火に続いて燃焼室点火を行った場合の機関回転数に対する点火時期特性図である。
【図８】この発明の他の実施の形態を示す圧縮自己着火式ガソリン内燃機関の全体構成図である。
【図９】図８の圧縮自己着火式ガソリン内燃機関における電子制御ユニットによる各点火プラグの点火制御動作を示すフローチャートである。
【図１０】燃焼室と副室とを連通する噴口の形状図である。
【図１１】噴口の他の例を示す形状図である。
【図１２】噴口の中心を副室の中心に対して偏心させた例を示す断面図である。
【図１３】副室と燃焼室とを連通する第２の噴口を、燃焼室内点火プラグに対向するよう設けた例を示す断面図である。

【符号の説明】
３　ピストン
５　燃焼室
１７　高圧燃料噴射弁
１９　点火プラグ
２１　副室
２２　噴口
２３　副室用点火プラグ
２９　電子制御ユニット（制御手段）
３７　吸気温センサ
３９　カム作動角センサ
４５　空燃比センサ
４７　振動センサ
４９　切替スイッチ
５１　第２の噴口

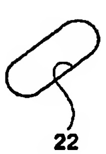
【図１】



【図２】

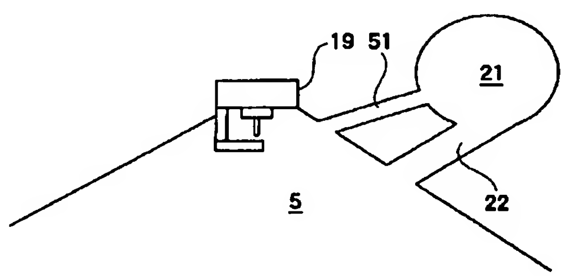


【図１０】

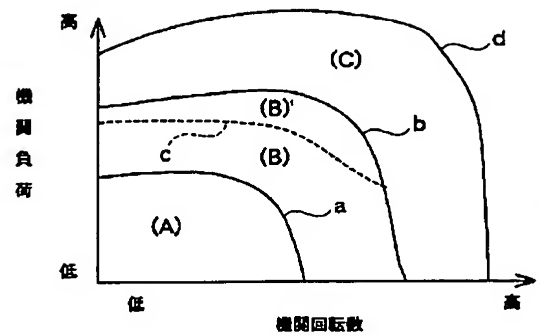


【図１１】

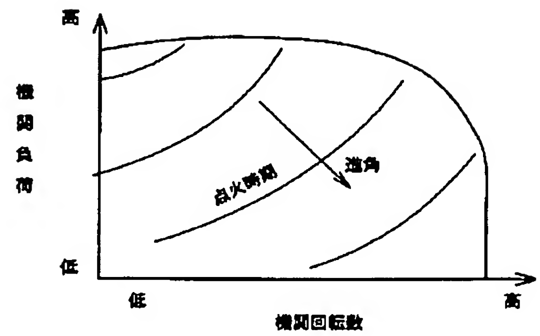
【図１３】



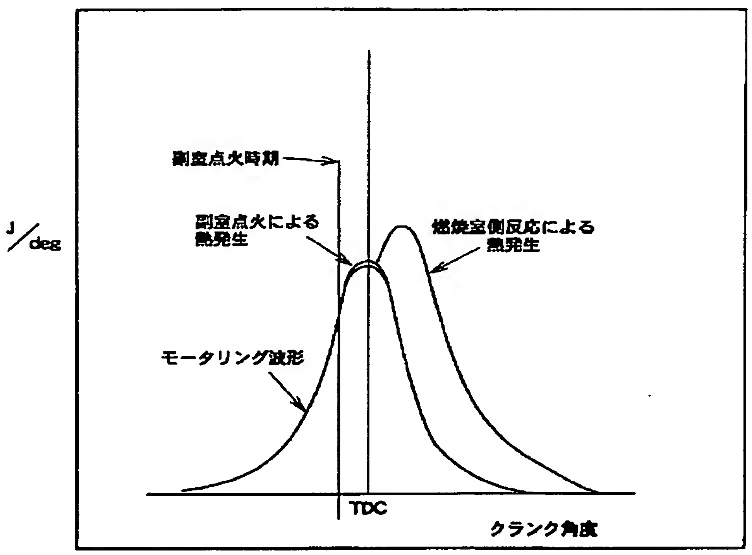
【図３】



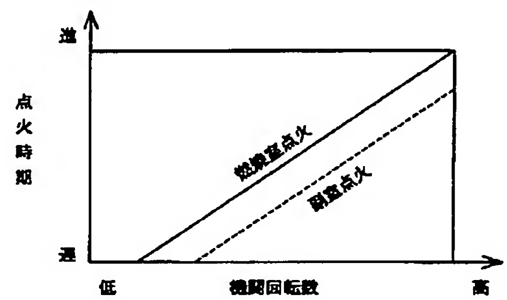
【図４】



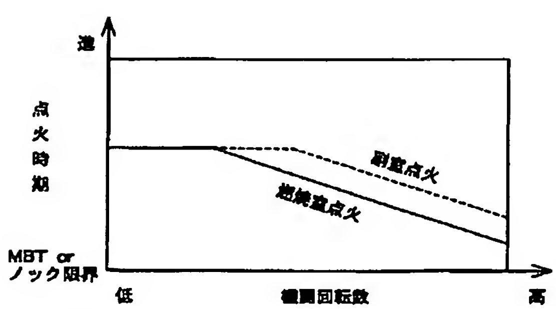
【図５】



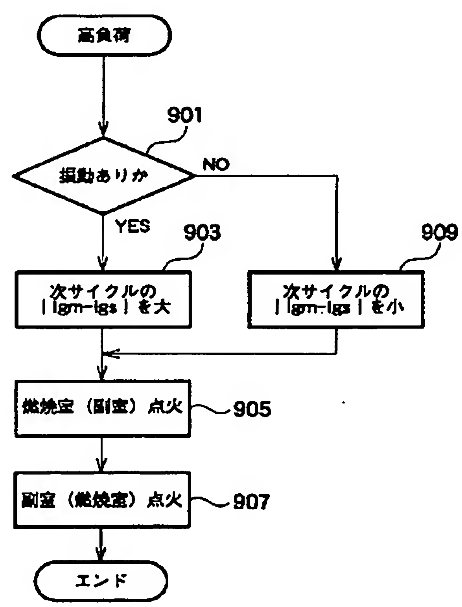
【図６】



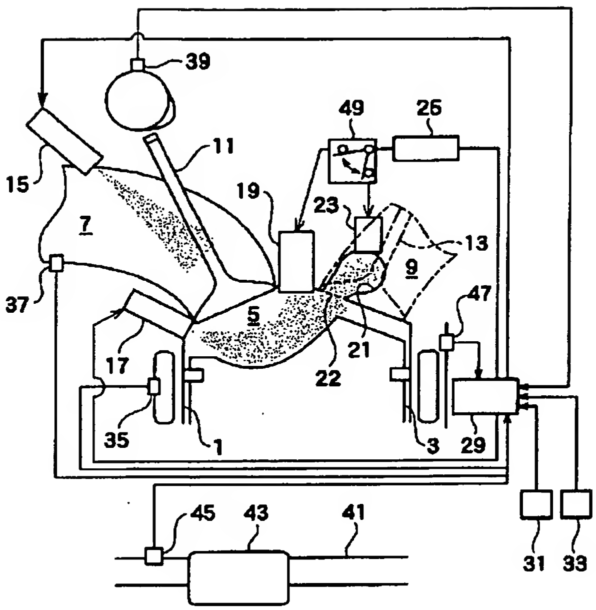
【図７】



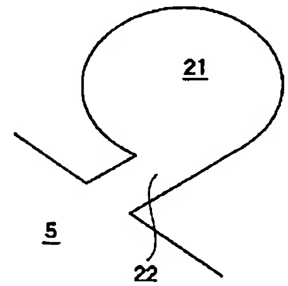
【図９】



【図８】



【図１２】



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	13/00	３０２		5/15	Ｄ
	15/08	３０２			

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